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SCIENCE

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Volume 122, Number 3162

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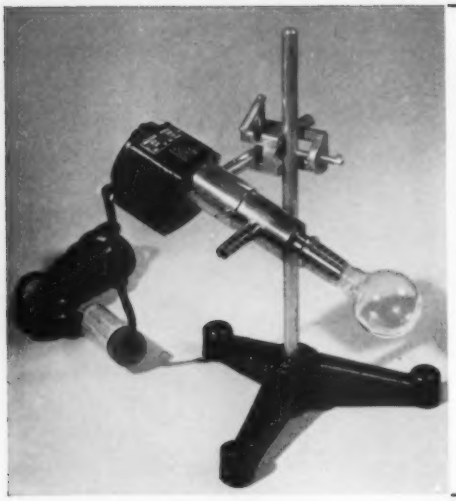

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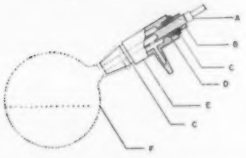

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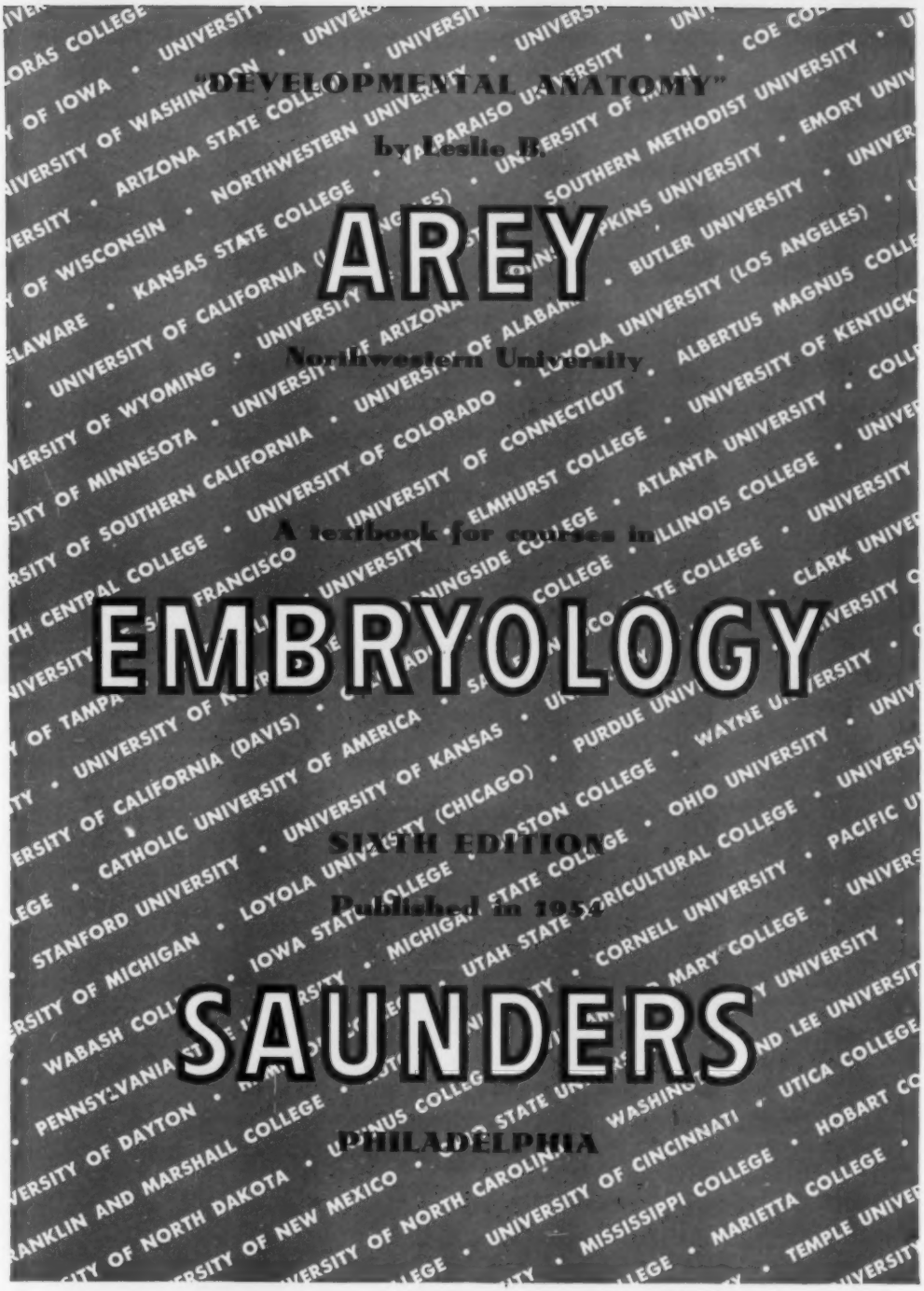

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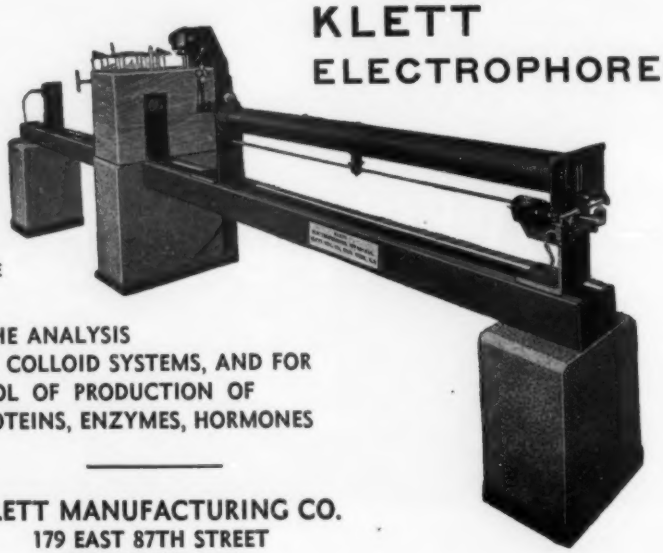

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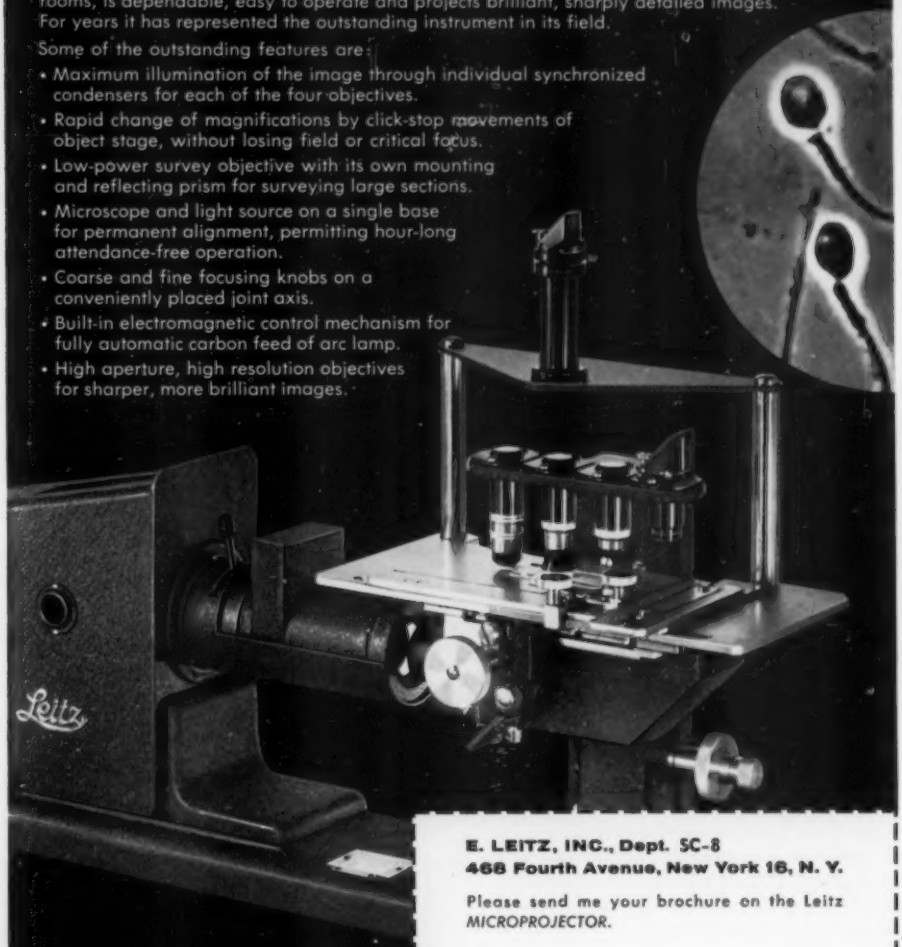

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Reactions to the changed format of *Science* were quick, vigorous, and varied. Letters, cards, and telephone calls have expressed, usually, enthusiasm, and, sometimes, dislike. A sampling:

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"I like the new set-up exceedingly, with the following exception. I *don't* like the type for the names of the scientists under 'Scientists in the News' and 'Necrology.' "

"I venture to offer one criticism. I find that use of capitals, instead of the boldface used in the old format, for the names of persons in such lists as 'Scientists in the News' and 'Necrology,' greatly increases the length of time required to scan the list and pick out items of personal interest."

The greater difficulty of scanning a page to locate quickly the names of persons one wants to read about was the most frequently mentioned criticism of the new format. The critics are right, even though, on the same change, other readers complimented the improved appearance secured by eliminating the scattered use of boldface type.

The staff members and consultants who developed the new format are naturally pleased by the compliments and by the fact that favorable reactions have been much more numerous than unfavorable ones. But there is not much to do about a compliment except to say "Thank you." The unfavorable comments have the additional value of being very explicit about what the author does not like. Not all criticisms can be satisfied, but they can be considered and used as guides for possible further improvements.—D. W.

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Biological Roots of Psychiatry

R. W. Gerard

A current joke has it that neurotics build castles in the air, psychotics live in them, and psychiatrists charge both of them rent. In like vein, I suppose I should add, the biologist tries to supply pilings down to earth. This is implied also by the metaphor of my title, for roots notoriously get down to and into the earth. They are less lovely, perhaps even less immediately useful, than the flowers and fruits, but they seem to be a fairly essential condition for the latter. The roots and fruits of psychiatry differ from one another as sharply as do those of plants, and the reasons for this will be worth our brief attention.

The biological roots penetrate from the individual, through the organ, to the cell or even the subcellular level. At such "kitchen" levels of the living, the turnover of substance and energy is the dominating concern, and the primary drives are for an adequate continuing supply of these for the metabolic turnover essential to dynamic, open-ended, equilibrium systems. The fruits, on the contrary, although they also start at the individual, expand to the levels of group and society. Here communication and meaning dominate rather than matter and energy, and the secondary drives become more important—those favoring group existence and involving interpersonal relations.

Interpersonal behavior is but a small sector of the entire range of animate behavior but, like the single octave of visible light in the entire electromagnetic spectrum, it has a unique importance to social man. It therefore deserves the intense scrutiny it is now receiving; it well merits examination under the oil-immersion lens. Biology supplies an arm and fingers, a skeleton and muscles, and a reflex and "voluntary" control of movement; but it cannot yet account for the individual characteristics of each person's handwriting. Biology can pretty well characterize the violin but is only on the edge of understanding why one person plays sweetly and another does not. The biologist is happy to recognize that two men or two violins are more like each other than like anything else in the world; psychiatric practice takes the violins for granted and is concerned with the sour notes that come from certain ones. Biological science seems to deal with the Cheshire cat; mental science, with its smile. But psychiatry, perhaps somewhat in contrast to psychology, is firmly based on its biological and medical origins. In this epoch of rapid transition, psychiatry is indeed unhappily schizophrenic, rooted in biological science and the body, and fruiting in social science and the nuances of human interaction. Like the mother church, in the speaker's eulogy, "There she stands; one foot firmly planted on the ground, the other raised to heaven."

Meaning and information, in turn, imply a knower and a user and, thus, a purpose. It is no accident that teleological explanations come so easily in this area and that nonmaterial causes are so readily accepted. It is simple to grasp the significance of a sterile wife dreaming of babies or of a thirsting desert wanderer hallucinating oases. More, it is possible to see a purpose or function, at least in the second instance; the need of water somehow increases restlessness to seek and focuses attention and perception on the object sought. The trick is in the word *somehow*. To understand the reason for, or object of, an act or experience is not yet to understand it adequately; a mechanism must also be revealed. Only when the action of an increased plasma osmotic pressure on the appropriate specialized neurones in the hypothalamus is laid bare, and dozens of additional mechanisms, does understanding approach the level of mastery and control. "Mechanism adds utility to truth"; we still have to discover the osmoreceptors of hallucinations and the chemoreceptors of dreams!

Incidentally, the problems of stress, in its most general use, and of psychosomatic disturbances and the organ neuroses in particular, bear an inverse relation to mental disease in that they tend to root in the social sphere, with faulty interpersonal relations, and to fruit in the biological sphere, with disturbed body or organ function. It is also worth comment that psychiatry, as compared with neurology, for example, is dynamic and vague, as is perhaps physiology as compared with anatomy. From physiology (*physiologoi*, which included all who sought *knowledge of nature*) were born successively: anatomy, asking "where" and concerned with the spatial relations of living things (the space or centimeter or *c* dimension); biochemistry, asking "what" and concerned with the materials of living things (the matter or gram or *g* dimension); and, in birth, biophysics, asking "when" and concerned perhaps equally specially with change and action (the time or second or *s* dimension). But the relatively amorphous and holistic physiology, asking "why" and "how," remains undiminished; it will yet be fertilized by many seeds from the unknown and give birth to many daughters, as yet unenvisioned. Perhaps psychiatry is cast in a comparable role.

We all agree today that brain and mind are related; that, contrary to Alice's experience in Wonderland, the grin cannot remain after the cat is gone. But the implications of this are often overlooked. A vital force does not move a molecule, and an emotion does not discharge a neurone. When experience leaves an enduring trace, it must be some sort of material imprint; and, so to speak, there can be no twisted thought without a twisted molecule. Perhaps the simplest

Dr. Gerard is professor of neurophysiology and director of research of the Division of Psychiatry in the Neuropsychiatric Institute, University of Illinois Medical School, Chicago; he has spent this year on leave at the Center for Advanced Study in the Behavioral Sciences, Stanford, Calif. This article is based on the 1955 Academic Lecture given by Dr. Gerard at the annual meeting of the American Psychiatric Association, 9–13 May, in Atlantic City, N.J. It is being published simultaneously in the *American Journal of Psychiatry*.

generalization to keep in mind is that all behavior in the external world, as well as all awareness of it, depends explicitly on the discharges of neurones. Certain neurones are fired by a given sensory input, these activate others and still others, and in time certain final neurones activate particular muscles to contract or glands to secrete. Clearly, the properties of the neural units and of their relations are crucial to all normal and disturbed behavior.

Mental Disease

In fact, the simple recognition of a dichotomy between unit and pattern at once sheds considerable light on mental disease, for a disturbance in the unit is likely to be quite a different affair from a disturbance in the pattern. Let me exemplify the point with recent illumination on muscular dystrophy. This disease has been regarded by many as resulting from a deficiency, comparable to the muscle pathology produced by lack of vitamin E, or to some endocrine error, or to some other unfavorable condition in the organism; and the importance of a hereditary factor has also been much debated. It proved not too difficult for workers in my laboratory to prepare tissue cultures of muscle from normal men and from dystrophy patients. Although both kinds of culture were maintained for months, in identical media and with repeated transfers, the dystrophy muscle continued throughout to exhibit characteristic abnormalities in size, striation, nuclear position and division, and so forth. Such findings are direct evidence of a difference in the unit itself, whether or not additional organismic disturbances are involved. Moreover, it makes a hereditary defect highly probable, although it does not entirely exclude the possibility of an irreversible change in the cells, produced, after they were formed, by some abnormal experience.

Another example of close relevance would be a blindness resulting from damage to the visual units, as when the retinal receptors actually degenerate under sufficiently severe and maintained vitamin-A lack, contrasted with damage to the normal connections in the optic system (more accurately their failure to develop), as when chimpanzees raised in total darkness cannot later in life recover usable vision. Again, the degeneration of anterior horn cells in polio patients constitutes a lesion at the unit level, but the comparable muscle weakness or paralysis that appears in cases of periodic family palsy and results from a block of junctional transmission by abnormal potassium content of the blood is equally clearly a disturbance in the connections. It is perhaps worthy of note, also, in the periodic disease that it is a hereditary defect, even though the malfunction of the neuromuscular system is a secondary one and consequent to disturbances elsewhere in the organism.

Such considerations may help point up, if not resolve, the differing claims regarding schizophrenia. If a characteristic abnormality is regularly demonstrable in cells of schizophrenics, as it is for the carbohydrate metabolism of erythrocytes examined *in vitro* (reported last year by Boszormenyi-Nagy and Gerty, from the Illinois Neuropsychiatric Institute), a biochemical or metabolic lesion at the unit or cellular level is practically certain. This again implies strongly a hereditary defect, in this case well supported by the familiar genetic studies on twins and probands, but it by no means excludes additional factors, organismic or environmental, which contribute to the manifest symptoms. It is indeed possible, as has often been suggested, that there is a disturbance between cortical and hypothalamic or other primitive segmental structures; but this cannot be the "full" explanation. I have personally speculated on the possibility of a disbalance between the specific and nonspecific systems from the more ancient nerve groups that act on the cortex. The specific thalamic system is concerned with the content of consciousness, the nonspecific one, with the degree of attention and of affect associated with consciousness. The dissociation of emotion from experience is perhaps the most characteristic sign of schizophrenia; moreover, it is striking that leucotomy also removes emotion from experience—as for example when the suffering associated with pain is eliminated while the direct pain perception is left unaltered.

In general, there is a sort of pyramid from etiology to symptom. Many different etiologies may initiate the same train of pathogenic events; many different pathogenic sequences may produce a single pathology; and many different pathologies may still lead to a single symptom. Thus blindness, as an example, can result from destruction of any portion of the optic system, from retina to cortex; destruction at the chiasm, say, can follow trauma, tumor, infection, and so forth; an infection and abscess, as the pathogenic process, can result from infection by one of many organisms, as a direct etiologic agent, abetted by defective host resistance, and like factors. Can it be doubted that mental disease, also, presents symptoms and even syndromes that may subsume multiple nosologic entities and are almost certainly based on multiple chains of abnormalities? Nonetheless, the present evidence seems to me to speak strongly for heavy weighting of an inherited biochemical aberration as a dominant factor in the causation of schizophrenia. Indeed, it deserves thought that the psychoses — notably schizophrenia and cyclothymia—may be primarily disturbances of the units of the nervous system, biochemical in nature and genetically carried; whereas the neuroses may be primarily disturbances in the patterns of function and interconnections of the neurone units, weighted on the physiological rather than the chemical, and resulting more from unfortunate relations of the individual to his environment than to his ancestors. Whether or not this sharp dichotomy is valid for all neuroses, it seems probable for the stress, anxiety, and psychosomatic disturbances.

Neural Units

It is time now to turn explicitly to modern neurophysiological knowledge, concerning first the units of neural function and then their patterns. The units, the individual neurones, can vary from one to another or from time to time in their thresholds of excitation, the related membrane potential level, the number and timing of their discharges, and the character of their metabolism. These attributes of a given cell are, in turn, normally controlled by impulses arising from other regions, by fields surrounding them — both electric and chemical — which result from changes in the blood supply or composition or directly from altered activity of other cellular units in their immediate neighborhood, and, as fairly basic to the electric and physiological shifts, by their own metabolic activity. Since I have discussed most of these points elsewhere, so far as their necessary relations are concerned, I should like now only to mention a few new observations from my laboratory bearing on the metabolism of neurones. This is the more pertinent in view of the opinion expressed in the preceding section that the psychoses are predominantly associated with disturbances in neurone metabolism. Many of my colleagues have been responsible for these researches; I shall not name most of them, but must mention at least L. Abood, A. Geiger, and E. Sigg (*1*).

It has long been generally accepted that glucose is the unique and even sole substrate for the central nervous system. Although this was early shown not to hold for peripheral nerve, and although various simpler substrates, such as glutamate, were shown to be metabolizable by brain slices or brei, the R.Q. of practically 1.0 and the extreme malfunction with hypoglycemia kept glucose in the fore of our thinking. It has now proved possible, using the perfused cat brain, left in physiological connection with desired parts of the organism but supplied exclusively by known nutrients, to dem-

onstrate the maintenance of essentially normal function for hours in the complete absence of glucose. Since the fluid entering and leaving the brain was analyzed, as well as appropriate samples from the brain itself, it can be stated positively that no carbohydrate is utilized under these conditions. Further, when the cortex is excited by stimulation of the brachial plexus, there is a considerable increase in the nonprotein nitrogen of the effluent and an even larger and fully reversible decrease in the nitrogenous groups of the brain lipoproteins and nucleoproteins. Convulsive brain activity, induced by Metrazol or electric stimulation, is associated with a large increase of oxygen consumption; but, even when adequate glucose is available in the perfusion fluid, the corresponding increase in glucose uptake occurs after the increased oxygen use is past and, moreover, it can be accounted for entirely in terms of lactic acid output. Indeed, it is even possible under appropriate conditions, such as curarization, to obtain perfectly characteristic convulsive discharges from the perfused brain with no increase in oxygen utilization.

Perhaps even more surprising, according to contemporary views, is the finding that activity is associated with a decreased formation of energy-rich phosphates—a decrease that might entirely account for the fall in creatin phosphate and ATP, even if there were no increased breakdown. This decreased formation has been demonstrated with the aid of tracer phosphate — in rat brains convulsed with Metrazol *in vivo*, in frog muscle subject to polarizing or stimulating currents, with or without actual contraction, and in peripheral nerve tetanized in the usual way. Since a decrease in these compounds resulting from slowed production, rather than from hastened destruction, would not be associated with increased energy output, these findings—along with several others already reported — suggest that the energy-rich phosphates may have some other function than as an energy source for action. In muscle, they are clearly related to the magnitude of the membrane potential and this, in turn, to the threshold for excitation; and similar relations almost certainly obtain for nerve fibers and neurones.

The level of ATP and CrP might thus be associated with the irritability of the brain rather than with its actual response; with communication rather than with energy. In accord with such considerations, we have found that the content of energy-rich phosphates in the brain of audiogenic mice is definitely below normal during just that period of the lifespan, approximately 30 days after birth, when the animals are susceptible to sound-induced convulsions. Since the lowered organic phosphates are found in the brains of animals that are sensitive to convulsions—as identified by the pure-breeding genetic stock—but have not in fact been convulsed, the low level could not be a consequence of convulsive activity but must be antecedent to it.

Comparable findings have been made on the isolated mitochondria of brain, which also decrease their phosphorylation, while increasing their oxygen consumption, under the influence of exciting electric pulses. These changes, characteristic of normal physiological responses, are in turn related to the presence of sulfhydryl groups and to a shift in potassium ion between the inside of the particulate and the surrounding medium. In fact, the failure of liver or kidney mitochondria to show this metabolic response to excitation may well be associated with the different potassium content or ratio of these organelles. That the particulates in neurones may indeed normally participate in the excitation and recovery processes is further shown by the finding that the microsomes of cortex neurones disappear reversibly when they are stimulated, in the perfused brain given drug convulsions or in tissue culture subjected to electric currents.

With the incompleteness of our knowledge of neurochemistry and of the metabolic concomitants of normal activity, as exemplified by such recent findings, it is not surprising that whatever changes may be present in particular psychoses have not been previously firmly established. It also seems reasonable, with the rapid increases in interest in and knowledge of neurochemistry, to expect that major advances in this direction are imminent.

Neural Patterns

Turning now from the units to the patterns, attention also shifts focus from neurochemistry to electrophysiology. In this domain are the properties of synaptic connections, the structure and reverberating characters of nerve nets and loops, the shape, intensity, and spread of electric and of chemical fields and the associated synchronization of electric rhythms and discharges. Under the influence of the modern theoretical and engineering considerations that have become known under the term *cybernetics*, much attention has been given to the continuous or discontinuous character of the interactions in the nervous system; and perhaps this is as useful way as any to open the discussion of patterns.

The nerve impulse itself is atomic or discontinuous *par excellence*. It behaves in characteristic all-or-none fashion; the impulse, if it occurs at all, is the "all" or maximum of which the nerve fiber is capable at the time. This behavior, in turn, is a necessary consequence of the high factor of safety in the nerve fiber. The eddy current that flows from an active region and constitutes the stimulus for a new region to be activated is normally some 8 times greater than the threshold of the inactive region. If the original stimulus, then, exceeds some critical intensity and fires one part of the nerve, the stimulus generated there is far more than enough to propagate excitation to other regions. Even considerable changes in the size of the action potential or in the threshold of the fiber are thus swamped out by the overpowering drive.

In contrast, most synapses show a low factor of safety—in fact, a factor less than 1. With few exceptions, a single impulse reaching a synapse does not suffice to fire the postsynaptic neurone; only when several impulses have managed to sum their effects, spatially or temporally, does a message carry through and the postsynaptic neurone fire. Synaptic action is thus continuous or analogical rather than discontinuous or digital, as has often been assumed; and graded effects, rather than trigger or threshold ones, operate there. The same is true for electric or chemical fields in the brain; these are by nature continuous and graded and can shift smoothly in intensity or position. In fact, even nerve nets, with multiple neurones and myriad connections, although discontinuous in the impulses shooting about them, are in effect continuous in their operation because of the statistical averaging over large numbers of individual units.

Messages thus enter, leave or rattle around in the nervous system as discrete signals, yet the interactions within the nervous system—which determine the patterns of activity—are mostly continuous, in actuality or in effect. It is no accident that modern information theory, concerned with factual bits of *yes-no* alternatives, and probability theory, concerned with continuities of expectation, both find increasing application in unraveling the tangled patterns of neural interaction; nor is it surprising that the two-valued Aristotelian logic is yielding to its more permissive multivalued modern derivative in rendering assistance. These considerations, moreover, are not remote from the immediate future of psychiatry. I am satisfied that the greatest barrier to rapid advance in psychiatric research today is the continuous and anecdotal character of the descriptive material on which psychiatric insights and generalizations are almost exclusively based. When more useful categories have been recognized and at least ordinal scales established, when it is possible to group the phenomena into classes and categories in a meaningful manner, rapid

progress is certain to follow. This is really the familiar problem of nosology in disease or typology in individuals or populations. But this implies just the kind of interplay between continuous and discontinuous that has been under discussion. When the input to our biological calculators has been effectively coded, the rules of operation already built into these nervous systems will suffice to grind out important answers in the mental area, as they have already in the physical and biological ones.

Electric and chemical fields can strongly influence the interaction of neurones. This has been amply expounded in the case of the electric fields. Changes in direct-current potentials have been shown to start, stop, or modify brain rhythms; and changes in the potentials have been seen to accompany changes in activity evoked in other ways, for example the diphasic direct-current shift accompanying cortical depression waves. The influence of potential fields and the resulting local currents in bringing about neurone synchronization are also well known, and I have suggested a hypersynchronization of beating neurones as a neural mechanism underlying causalgia, motion sickness, and neurosis. It will, therefore, be more profitable now to direct attention rather to specific chemical effects and to the influence of one molar brain region upon another, by whatever mechanism. Of special interest in recent years have been the hypothalamic and medullary reticular formation, the interlaminar nuclei in the diencephalon, and other particular structures at the upper end of the old segmental brain stem; and the influence of these upon cerebral activity is obviously of primary concern to psychiatry.

Sympathin and Consciousness

Not only can stimulation of these deeper structures lead to increased or decreased electric and functional activity of the brain and cord; we have recently found a small region, near the mammillary bodies, stimulation of which can double the oxygen consumption of the cerebrum. This increased metabolism, moreover, may outlast the period of stimulation by many minutes—a point to be considered shortly in connection with the action of epinephrine. Indeed, the specific chemical and metabolic properties of these "autonomic" centers almost insure a rather special functional role. Thus, the reticular formation is particularly sensitive to narcotics; mescaline and like agents are reported to cause spiking in the hypothalamus; most autonomic centers are highly resistant to low oxygen and carbohydrate and to high carbon dioxide; these diencephalic structures are rich in sympathins; and, as we have recently found, both bulbocapnine and chlorpromazine inhibit phosphorylations specifically in the basal ganglia-thalamus region of the brain, while affecting that of cortex little or none. Moreover, adrenalectomy in rats leads to an increased ratio of creatine phosphate to inorganic phosphate in these basal structures only, and large epinephrine doses inhibit phosphorylation in this same region.

Many workers are now relating the level of activity of these deep structures —exactly which is far from agreed upon —to the level of normal awareness, from sleep to alertness, and associate their overactivity with disturbed mentation. The psychosomimetic action of mescaline, lysergic diethylamide, amytal, and some adrenalin derivatives has been seen as a paradigm, if not as the actual mechanism, of the pathogenesis in schizophrenia. A faulty epinephrine metabolism has been specifically suggested, and schizophrenic blood has been reported to contain a different adrenalin than normal, perhaps adrenoxime, and to be able to degrade injected epinephrine only abnormally slowly. Whatever the disturbances may be in psychoses, it is of some interest to reexamine the significance for normal behavior of epinephrine action on the central nervous system.

Most behavior is unconscious. Why is consciousness attached to or concomitant with certain acts and experiences? It is certainly true that awareness is most acute in association with disturbing events and is most in abeyance when the surface of existence runs smoothly and placidly. Extensive and splendid mechanisms have evolved to meet, adaptively and automatically, the usual situations encountered in the life of an organism; it is only when such adaptive behavior fails that innovative or creative behavior and the attendant consciousness are called into action. In neurological terms, if the automatic response fails to remove the disturbing stimulus, if the simple negative feedback mechanism fails, then impulses will continue to arrive at particular neurone groups in greater numbers than normal. Some kind of summation is highly probable—the mechanisms for this, at least at synapses, are reasonably well understood—and impulses will now irradiate to additional neurone groups beyond those normally activated. Progressive radiation of activity in the nervous system, under cumulative stimulation, is a well-known and fully documented phenomenon. As judged by the subjective and objective evidence of mounting affect when a disagreeable experience is continued, as well as by the physiological evidence of increased autonomic activity, one important direction of radiation is to the hypothalamus and related structures. From such activation, in turn, result an outflow of impulses up and down the neuraxis and, quite possibly, a direct liberation of sympathins. But the conditions just described are those of emergency or stress, long known to be associated with activity of the adrenals.

The adrenal medullary hormone, epinephrine, but not the closely related norepinephrine, has fairly dramatic actions on the nervous system, and a considerable outpouring of epinephrine does follow hypothalamic stimulations. This substance considerably increases the oxygen consumption of the cerebrum, assumed to be by a direct action on these neurones. In view of the evidence mentioned earlier—of the existence of hypothalamic centers, excitation of which doubles cerebral oxygen consumption, and of the excitant action of the sympathins on such centers—it should be considered whether this effect also is an indirect one from the diencephalon. Epinephrine can, moreover, considerably enhance or, especially with larger doses and deeper anesthesia, depress motor responses obtained from stimulating the motor cortex or those of the knee jerk; and, in the latter case, not all the changes are abolished when diencephalic and medullary influences have been eliminated by spinal section. In general, parasympathetic activity overbalances that of the orthosympathetic system in sleep, and increased orthosympathetic activity leads to arousal; indeed, a moderate epinephrine injection can rouse an animal from moderately deep anesthesia. Perhaps the concentration level of adrenalins, or more generally sympathins, acting on the brain is a significant determinant of the level of consciousness.

We have been able to show, by infusing healthy young adults with epinephrine solutions at only 2 or 3 gamma a minute, that psychological effects are produced in the complete absence of vascular or other peripheral signs. (By contrast, much larger infusions of norepinephrine can produce vigorous cardiovascular changes, even abdominal cramps, with no change in mental state.) Minimal epinephrine does produce a fine tremor, increased unsteadiness, and enhanced word fluency; no other tests revealed differences. More striking than any change revealed by objective tests, was the subjective report of a feeling of anxiety and apprehension. Such feelings have been experienced by all subjects; and some individuals, presumably with a high preexisting level of conflict and apprehension, approached collapse.

It is tempting to think, then, that an unresolved and therefore stressful situation leads to neural activation of primitive brain-stem structures, this to the liberation of sympathin-type agents, and

these, by a positive feedback upon the brain, to increased attention, alertness, and anxiety. It is not an unlikely extrapolation that still larger doses or more active derivatives could stimulate still further and produce hallucinations and disorientation and, in general, be psychosomimetic. An oversusceptibility of neurones might be an additional factor in the true psychoses. In fact, such considerations lead us back to a reconsideration of consciousness and memory, this time in terms of circuits and neural nets rather than of electric and chemical fields.

Memory and Circuits

The notion of neurones connected in a network, not merely in linear series, and of nerve impulses passing about the connections in a circular, more or less continuing, fashion, is now widely accepted. Actually, such reverberating circuits have been demonstrated only over gross levels of the nervous system, as between cortex and thalamus (we are finding suggestive evidence of their functioning in the frog's olfactory bulb in normal olfaction), but the sort of dynamic action that is possible in such circuits or assemblies is just what the physiologist ordered to account for the less automatic and immediate aspects of behavior. So, whether or not it is finally correct, it will be useful to explore further some of the behavioral consequences that can flow from reverberating neurone circuits. It was early pointed out that such circuits free behavior from being time-bound to the stimulus. Conduction and synaptic times no longer set the limits between stimulus and response; a neurone chain, once activated by a stimulus, might continue to reverberate indefinitely and so to serve for a maintained new behavior, for behavior appearing intermittently, or even for memory records that could play into consciousness on appropriate triggering. There are, in fact, some highly interesting relations possible between memory traces and nerve impulses running in circuits.

We were able to show that memory does not depend on the continuing operation of active neurone circuits or assemblies, by stopping brain activity with deep cold or by discharging all neurones simultaneously with an electric shock—either of which maneuvers should terminate any active patterns of reverberation. Hamsters, so treated after mastering a maze, showed full retention of their learning. But it was also found, by altering the interval between each learning experience and electric shock, even though a set of runs and a shock were given every 24 hr, that memories required a certain time to become fixed in the nervous system. Thus, when shocks followed trial runs by an interval of 4 hr or longer, the learning curve was as good as when no shocks were delivered; when the interval between experience and shock was reduced to 1 hr, some defects began to show; at 15 min learning was seriously retarded; and at 5 min or less it simply did not occur. Human experience takes meaning in the light of these experiments; after a concussion, memories may be much disturbed and then return in order from earlier toward more recent times, but the events over the few minutes to an hour or so prior to the brain shock are usually lost forever. Presumably, here also the necessary time for fixation, between initial experience and the laying down of a firm mnemonic trace, was lacking.

We have further found that the temperature coefficient of this fixation process is well over 2, perhaps closer to 3, since hamsters kept cool during the interval between experience and electroshock show as great a disruption of learning at an interval of 1 hr as warm ones do at an interval of 15 min. Whether or not this stout temperature coefficient indicates a chemical process in laying down the engram—an issue that is irrelevant to present considerations—it is satisfactory to find such physical regularities in the memory process; especially since the temperature coefficient is comparable to that reported decades ago for the passage of subjective time.

Our immediate concern is the possible relation of these phenomena to reverberating circuits. It may be that the single passage of an impulse over a neurone loop leaves no significant trace but that repeated passages in a limited time sum their reversible effects until some irreversible level is passed. A single water drop can leave a sandhill undisturbed, but a series of drops produces a runoff channel. If messages continue to circulate in a neurone loop, their continuing reappearance at particular junctions over minutes or hours might be required before the critical material change that constitutes a relatively permanent memory record could be produced. In much the same way, tetanization of a presynaptic nerve fiber for a few seconds can lead to marked and enduring enhancement of the number of postsynaptic units that it can excite. The temperature coefficient might thus be determined by the rate of reverberation, the speed of chemical fixation, or one of several other possible variables; but, whatever the details, something of this general character is strongly indicated.

A final point on memory has to do with localization. This again is not part of the main theme, but it is significant that, if memory traces are deposited at multiple loci in an activated neurone assembly, several conflicting phenomena concerning localization seem explicable. Punctuate stimulation of the temporal cortex evokes, at least under some conditions, highly specific recall of past experiences; this indicates a sharply localized engram. Conversely, localized lesions in the brain, even fairly extensive destructions, are unlikely to abolish memories, at least beyond the major modalities encountered in the aphasias. If the neurone assembly involved in a given experience is, as the term *assembly* implies, not a single loop but a multiply linked network of loops, a memory would not be entirely lost unless all parallel paths of the net were destroyed, whereas it might still be elicited quite specifically by stimulating any one appropriate locus. Thus, as is shown in Fig. 1, a memory would be lost only when both *A* and *B* were destroyed; it could be evoked by stimulation of either one alone. Such a picture would, of course, predict that a given memory could be evoked on stimulation of more than one point; but, since the anatomical distribution of such loops is completely unknown and observations on man are difficult, it is not a serious objection that such multiple loci have not been encountered. It is only half a decade since specific memory loci were discovered; half a century elapsed between the discovery of primary motor and sensory areas of the cortex and the discovery of secondary ones.

Consciousness and Circuits

If circuits enduring for minutes or hours may be required to fix experience in memory, perhaps circuits reverberating for seconds or fractions may be necessary even for the initial consciousness of an experience—or of some inner-triggered awareness. Such a hypothesis would deny that any subjective experience accompanies a single activation of any given neurone assembly (whether certain exceptions may exist is not now important) and would require the summative effect of at least a few reverberations before consciousness is aroused. This postulate leads to some interesting consequences. First, it fits the foregoing discussion concerning irradiation in the nervous system with unresolved problem situations. Consciousness and creative behavior are both evoked by the reverberation of circuits, while routine unat-

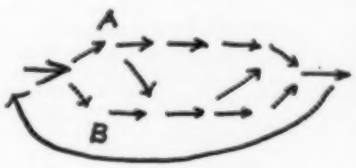

Fig. 1

tended behavior is presumably handled by messages running quickly and with no or minimal repetition through well-grooved "reflex" channels. Along the same lines, dreams might result from unresolved pressures left from the day or generated from the environment and would represent such continuing reverberation and irradiation in brain neurones (2). If dreams represent maintained brain activity—as borborygmi accompany a maintained digestive activity—their presence with unresolved situations is physiologically reasonable. The maintained stimulation might result from lingering concerns of the day, perhaps represented in reverberating loops in the diencephalon-cortex system sensitized or activated by an accumulation of sympathins; or from a maintained barrage of interoceptive messages, such as that produced by a filling urinary bladder; or from a similar insistent input of exteroceptive messages, say a ringing bell—all would favor the existence of dreams.

Much the same considerations would apply to hallucinations, such as those of water that are associated with thirst, to delusions, and the like. When neural activity is maintained, more and more neurone loops will be activated to the level that is associated with conscious awareness and with focusing of attention. Such a neurophysiological picture is obviously congruent with the psychodynamic one of drives or pressures that are unsatisfied, with the accumulation of something—unfortunately called energy—that finally overflows in healthy or unhealthy ways. If such biological considerations serve to account effectively for the existence of consciousness under given conditions, we need not be disappointed if the content of consciousness can be described at all now, and perhaps forever most usefully, only in terms of recent or early experience.

One final instance of a psychodynamic consequence of this postulate regarding consciousness must suffice. It has long bothered me that learned physical prohibitions remain fully conscious while those associated with enculturation are largely unconscious. Thus, a child learns by physical suffering that it must not touch hot objects, avoids touching them, and remains throughout entirely aware

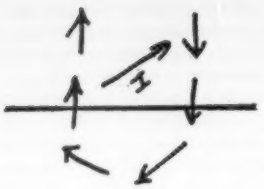

Fig. 2

of the complete relationship; but the same child, punished for hitting someone, gradually develops a superego which not only forbids the act but represses the entire constellation of urge and censoring. Aside from this difference in repression—which may itself have something to do with the repetition of the experience and the gradual accumulation of the inhibition—the following aspect of repression seemed quite inexplicable. Since the superego rules are learned, they are presumably associated with the cortex, and if their censoring action is to be evoked by a drive, this also should somehow involve the cortex. Yet, both the drive and the censoring remain unconscious. This is in conflict with our normal experience and expectation that activation of the appropriate cortical memory elements should be associated with conscious recall or awareness. In simple words, how can the censor censor and be censored without knowing what is happening?

Exactly the same problem arises with the recognition of words exposed tachistoscopically. Neutral four-letter words are perceived and correctly recognized after an exposure of about 0.01 sec; "dirty" four-letter words are not recognized unless exposed for twice as long. Clearly, these words must have been correctly identified in the usual time in order to be rejected from conscious recognition; again, learned patterns in the cortex must have been activated but not sufficiently to arouse conscious awareness. The hypothesis we are considering, that awareness results only with repeated activation of the appropriate assembly, by a brief reverberation, happily accounts for these phenomena if the first activation leads to inhibition. (In Fig. 2, *I* blocks impulses on the way to the cortex; so one passage only occurs.) And the same reverberation requirement for consciousness can simply account for subliminal perception and learning; it may even account for the seeming occurrence of perception in 0.1-sec frames.

Whether the various guesses I have dared to present here should prove, as is highly probable, partly or entirely incorrect is not so important as is the fact that today it is possible for neurophysiologists to make such informed guesses. Not many years ago such viewpoints were not only unavailable but would have been entirely unjustified by the evidence then at hand. I am particularly encouraged by the fact that this postulate concerning consciousness and the consequences that follow with regard to mental activity were triggered by very limited discussion with a psychoanalyst. Such discussion is one of the opportunities presented at the Center for Advanced Study in Behavioral Sciences, where psychiatrists and psychologists, as well as a neurophysiologist, happen to be fellows at the same time. With growing attention to interdisciplinary behavioral science, I am very optimistic regarding the progressive and increasingly valuable application of biological knowledge to mental phenomena in general and to psychiatry in particular.

Notes

1. Our thanks are due to the Office of Naval Research, to the National Institute of Neurology and Blindness and the National Institute of Mental Health of the National Institutes of Health, U.S. Public Health Service, to the Surgeon General's Office of the Army, to the Illinois Department of Public Welfare, to the Muscular Dystrophy Association, and to other agencies whose support has made these studies possible.

2. Incidentally, Freud's assumption that dreams exist to preserve sleep is not only unnecessary to his important interpretations of latent and manifest dream content and of the nature of dream work; but it also seems unsound physiologically. Physiological evidence is pretty conclusive that there is no dreaming during the deep sleep of most of the night, that dreams do occur in light sleep and during the waking-up process, but that their presence does not prevent the arousal from proceeding to awakeness. Conversely, internal or external stimuli may produce, during complete wakefulness, a wandering of attention and kaleidoscopic conscious content quite similar to that of sleep dreaming, and well called daydreaming. The hypnogogic awareness, associated with actually falling asleep, is also comparable to the dreams during sleep, supposed to prevent wakefulness. This physiological explanation of the existence of dreams in no way detracts from the validity of psychodynamic interpretations of the dream content, latent or manifest, or of the nature of dream work—all of which are now beyond neurophysiology.

The really great school and college teachers are not primarily teachers of biology, English or economics. They are teachers of young men and women. Their success can be measured by the degree to which they correct, humanize and enrich the student's perspective, and give him wider interests, new horizons, enlarged frames of reference, and those sounder habits of working and thinking which make it possible for him to discover the relevant facts in any field, and in his own reach valid conclusions.—CHRISTIAN GAUSS.

Metabolism and Chromosome-Break Rejoining

Sheldon Wolff and Henry E. Luippold

Since Muller's (*1*) original discovery in 1927 that x-rays can produce gene mutations, much study has been devoted to the effects of radiation on genetic systems. One area in particular, the production of chromosomal aberrations, has been rather well quantitated. This quantitative approach began with the work of Sax (*2*, *3*) and in the main was further pursued in the United States by Sax and his students and in England by Lea and Catcheside.

The results obtained by these early investigators were interpreted on the basis of a simple direct-action hypothesis. Reviews by Catcheside (*4*), Lea (*5*), and Giles (*6*) describe the development of this theory, which maintains that the ionizing radiations first break the chromosome threads. The broken ends can then (i) heal in the open position, (ii) rejoin by restitution, or (iii) rejoin with the broken ends of other chromosomes. The first of these three events leads to simple one-hit aberrations. The second is undetectable, and the third gives rise to two-hit aberrations.

It may be noted that the calculations of Lea indicate that 95 percent of the breaks originally produced restitute. Sax (*3*) observed that if a dose of radiation breaks two chromosomes in such a way that the two breaks are open simultaneously and are in close proximity then, by the process of rejoining, it is possible for a dicentric chromosome to be formed. Similarly, if the two breaks occur in the same chromosome a ring can be formed (Fig. 1). If, however, the total dosage is divided into two fractions, only part of the breaks are produced at a given time. When a long enough period elapses before the second fraction of the dose is given, this first group of breaks will restitute before the second one is produced. Therefore, the two groups of breaks will not be able to rejoin with one another to produce two-hit aberrations (Fig. 2).

In the seeds of *Vicia faba* the breaks usually stay open for the relatively long period of 30 min when they are irradiated in a vacuum and then restitute rapidly. The "open" period can be determined by the length of the period between two dose fractions that does not result in a decrease in the number of two-hit aberrations from what it would have been had the radiation been administered in one large dose. The quantitative aspects of this matter have been treated by Wolff and Atwood (*7*). Briefly, however, if the breaks from the first dose have rejoined before the second dose is administered, the yield of two-hit aberrations will be the sum of those produced by each of the two dose fractions. If the breaks stay open, the yield will be the square of the sum of the square roots of the numbers produced by each fraction.

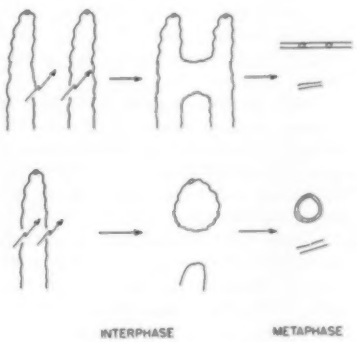

Fig. 1. Origin of two-hit aberrations. (Top) Dicentric; (Bottom) ring.

In the present experiments (*8*) we have tried to determine the mechanism of the rejoining process of broken chromosomes. Essentially, the procedure consisted of first irradiating *Vicia* seeds in a vacuum in order to produce breaks that would stay open for 30 min (*7*). Immediately after this first irradiation, various enzyme inhibitors were applied to test their effect on rejoining. Seventy-five minutes later a second fraction of radiation was administered to determine whether or not the first group of breaks was still open and capable of rejoining with the second group of breaks. Three days later, when the first mitotic root tip divisions were occurring, the roots were excised and placed in a saturated solution of paradichlorobenzene for 2 hr to accumulate metaphases. They were then fixed in C. E. Ford's modification of Flemming's fixative and stained with Feulgen reagent. Details of the technique have been given elsewhere (*7*). All irradiations were administered with a G.E. Maxitron tube operated at 250 kvp with 3 mm of Al filtration. The dose rate was 200 r/min. In each experiment 300 metaphase plates were scored for rings and dicentrics. The results are presented in Tables 1 and 2.

As may be seen in experiment 1, the breaks formed by irradiating with 600 r in a vacuum rejoin within 75 min if the material is left at room temperature (about 25°C). Actually, as noted, these breaks stay open for only 30 min. However, if the seeds are plunged into 0°C water immediately after the irradiation and kept at this temperature for the entire 75 min, ostensibly to stop all enzyme activity, the breaks stay open and are able to rejoin quantitatively with the breaks that are induced later (experiment 2). Similarly, postirradiation treatment with $2 \times 10^{-3}M$ KCN or with 95 percent CO-5 percent O_2 in the dark is able to prevent normal rejoining of the breaks, even at room temperature (experiments 3, 4, 5). If, however, the seeds in the CO mixtures are exposed to a light from a sodium arc lamp at a distance of 6 cm (720 ft-ca as measured by a Weston Illumination Meter 756 Viscor Filter), the CO inhibition of rejoining does not occur (experiments 6, 7).

These observatons indicate that the repair of radiation-induced chromosome breaks, as evidenced by rejoining, is dependent on oxidative metabolism, especially the part of oxidative metabolism that is mediated by cytochrome oxidase, which is inhibited by both KCN and CO. Consequently, the same results would occur if respiration were blocked by any mechanism other than the direct inhibition of cytochrome oxidase. In experiments 13 and 14, in which irradiated seeds were treated with a combination of $2 \times 10^{-3}M$ $Na_2S_2O_4$ and 4 to 5 mm of vacuum, the breaks did indeed stay open. Here the sodium hydrosulfite was used with the vacuum to remove completely the oxygen that might be present in the cells. Under these conditions of complete anaerobiosis, rejoining did not occur, a result that corroborates the hy-

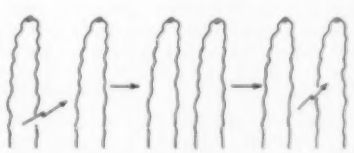

Fig. 2. Effect of dosage fractionation.

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Table 1. Effect of respiratory inhibitors on chromosome rejoining.

Expt.	Treatment immediately after dose 1 of 600 r in a vacuum at time t	Dose 2 at $t+75$ min (r)	No. of two-hit aberrations per cell			Occurrence of rejoining within 75 min
			Observed	Expected value*		
				With rejoining	Without rejoining	
1	Room temp.	400 (air)	0.220	0.193	0.380	+
2	0°C	400 (air)	0.367	0.193	0.380	−
3	$2\times10^{-3}M$ KCN	400 (air)	0.367	0.236	0.440	−
4	95% CO + 5% O_2 dark	400 (air)	0.347	0.193	0.380	−
5	95% CO + 5% O_2 dark	400 (air)	0.400	0.193	0.380	−
6	95% CO + 5% O_2 light	400 (air)	0.210	0.193	0.380	+
7	95% CO + 5% O_2 light	400 (air)	0.185	0.193	0.380	+
8	Vacuum 4 to 5 mm	600 (vac.)	0.200	0.184	0.365	+
9	Vacuum 4 to 5 mm	600 (vac.)	0.143	0.184	0.365	+
10	N_2 (pyrogallol)	400 (air)	0.147	0.193	0.380	+
11	N_2 (pyrogallol)	400 (air)	0.167	0.193	0.380	+
12	2×10^{-3} BAL	400 (air)	0.123	0.157	0.293	+
13	$Na_2S_2O_4$ + vacuum	600 (vac.)	0.400	0.184	0.365	−
14	$Na_2S_2O_4$ + vacuum	600 (vac.)	0.407	0.184	0.365	−

* Values column computed from numbers of aberrations produced by dose 1 and 75 min of postirradiation treatment as expressed in the second column; also from the aberrations produced by 75 min pretreatment and dose 2. Expected values are different, since some of the pretreatments change the numbers of aberrations produced by a given dose of radiation.

Table 2. Effect of 2,4-dinitrophenol on chromosome rejoining. DNP administered immediately after dose 1 of 600 r in a vacuum (75 min before dose 2 of 400 r in air). Expected two-hit aberrations per cell with rejoining, 0.193; without rejoining, 0.380.

Molar concn. of DNP	No. of two-hit aberrations per cell
1.5×10^{-5}	0.240
1.5×10^{-4}	0.377
3.0×10^{-4}	0.367
1.5×10^{-3}	Lethal

pothesis that oxidative metabolism is necessary for rejoining. However, it must be noted that $Na_2S_2O_4$ may also inhibit respiration by reducing hydrogen transport coenzymes in the system. The end effect, however, would be the same as if its only function were to remove oxygen. In experiments 8–10 it may be observed that 4 to 5 mm vacuum or nitrogen passed over alkaline pyrogallol, as utilized, are not in themselves sufficient to deplete the intracellular oxygen content of the roots within the time limits imposed by the nature of the experiment. Under these conditions the broken ends rejoined. Similarly, treatment with $2\times10^{-3}M$ BAL, which removes intracellular oxygen less efficiently than $Na_2S_2O_4$ (*9*), does not prevent rejoining (experiment 12).

Table 2 demonstrates the effect of various concentrations of 2,4-dinitrophenol on rejoining. Concentrations of either $1.5\times10^{-4}M$ or $3.0\times10^{-4}M$ caused the broken ends to stay open for the duration of the experiment (75 min). At the lower concentration of $1.5\times10^{-5}M$, an "either-or" reaction took place, with some of the root tips exhibiting chromosome breaks that stayed open and others exhibiting breaks that closed. Consequently, we think that at the lower concentration only some roots were affected by the DNP.

In view of these results it appears that the chemical bonds formed in the process of rejoining are probably strong bonds. We believe that the probable function of oxidative metabolism in this system is to provide the high-energy phosphate bonds of ATP that are utilized to provide the energy required in the synthesis of these bonds.

Previous work by King *et al.* (*10*) has shown that CO can increase the numbers of aberrations induced in *Tradescantia* microspores. They suggest that this might be caused by the formation of hydrogen peroxide through the pathway of the flavoproteins. That carbon monoxide does not work by this pathway in the present study is shown by experiments 13 and 14, in which complete removal of oxygen by $Na_2S_2O_4$ plus vacuum, which would preclude peroxide formation, prevents rejoining.

Haas *et al.* (*11*) have suggested that cytochrome oxidase and other enzymes connected with oxidative metabolism affect the breakage of chromosomes in *Drosophila*. This suggestion resulted from experiments in which treatment with CO began before irradiation and extended for 20 min after. They also noted an intensity effect of the radiation. In the light of the present study, the results they describe might well be ascribed to a postirradiation effect of the monoxide on the rejoining of the breaks.

In summary, we would say that the rejoining of radiation-induced chromosome breaks, with its formation of chemical bonds, is inhibited by low temperature, cyanide, carbon monoxide, anaerobiosis, and dinitrophenol. We are thus led to believe that oxidative metabolism with its concurrent formation of ATP is necessary for rejoining.

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Generally, when some new instrument in the equipment of civilization excites wonder, it is the mystery of the instrument itself, rather than the broad sweep of the basic principles of science, upon which amazement dwells: it is with the electrical gadgeteer, for example, more often than with Maxwell or Hertz, that the marvel of radio-communication is commonly associated.—NORMAN FEATHER, *Lord Rutherford* (1940).

News of Science

Pseudoalleles

Fifty years from now it seems very likely that the most significant development of genetics in the current decade (1945–55) will stand out as being the discovery of pseudoallelism. First found by E. B. Lewis in *Drosophila melanogaster* in 1945, no other genetic phenomenon recently discovered seems to have the generality of this one, or to promise so much insight into the nature of the "gene"—its action, its mutation, its evolution. The phenomenon is difficult to define precisely; in fact, different observers have set forward different criteria for its definition. In general, however, it means that mutant genes that were once thought to be alleles of one another, because they were located in the same chromosome and always seemed to segregate from one another, and because the heterozygote between them displayed a mutant phenotype that was commonly intermediate between the phenotypes of the two respective homozygotes, were now found by more refined and laborious tests to lie at different, although adjacent, loci capable of undergoing occasional recombination by means of genetic crossing over. Thus even the classical *Drosophila* series of multiple alleles at the white eye-color locus has been shown to involve two separate loci, representing the mutants "white" and "apricot," respectively.

The importance of this phenomenon in current genetics is well indicated in a symposium on *Pseudoallelism and the Theory of the Gene*, held by the Genetics Society of America last September, and now published [*Am. Naturalist* **89**, 65 (Mar.–Apr., 1955)]. M. M. Green and E. B. Lewis here discussed the known cases in *Drosophila*, Green emphasizing the relation of pseudoallelism to the gene concept and to the problem of the origin of new genes in evolution, while Lewis devoted himself to interesting aspects of the alteration in gene function occurring when the pseudoalleles are in *cis* or in *trans* arrangements in the two homologous chromosomes. J. R. Laughnan presented the first analysis of the existence of pseudoalleles in maize. Since this case involved the well-known series of alleles at the *A* (anthocyanin color) locus, it seems highly probable that other multiple allelic series in maize may also turn out to involve pseudoalleles. S. G. Stephens, who concluded the symposium, pointed out the existence of similar cases in cotton and dealt with the origin of new genetic loci from old ones by the occurrence of small duplications, or "repeats," in the chromosomes, followed by a gradual differentiation of function and increasing independence of action, until the new loci have passed beyond the stage of pseudoalleles into that of clearly distinct genes. It is his belief that in *Gossypium* probably all stages in this evolution of the gene can be found. Only C. Stormont, among the participants, sounded a note of reservation. In cattle, and similarly in man, there are extensive series of multiple alleles that determine various blood groups. In cattle, no case of recombination between the antigenic components of a single locus has been detected; and, although such recombination has been postulated to occur in human beings, and indeed has aroused acrimonious discussion, no crucial case has been reported as positive evidence of pseudoallelism.

Meanwhile evidence of the generality of the phenomonon has been growing rapidly. It has previously been reported in at least one microorganism, the mold *Aspergillus nidulans*. The June 1955 issue of the *Proceedings of the National Academy of Sciences (U.S.)* contains no less than three new reports of pseudoallelism. One, that of Green, demonstrates pseudoallelism at the classic locus of *forked* in *Drosophila melanogaster*, a locus that has been used in literally thousands of genetical experiments in the course of the past 43 years. The two others are even more startling. S. Benzer presents evidence of pseudoallelism in the *Escherichia coli* bacteriophage between two subgroups of *rII* mutants; and M. Demerec, I. Blomstrand, and Z. E. Demerec demonstrate the same for biochemical mutants in *Salmonella typhimurium*.

Benzer's evidence comes from crosses between two *rII* mutants made to infect the same bacterium in equal proportions. Eight different mutants were found to fall into two groups, of six and two, respectively. If both mutants belong to the same group, then a mixed infection of the susceptible bacteria gives the mutant phenotype, namely, a lysis of very few bacteria; whereas if the mutants belong to different groups, extensive lysis occurs, both types of phage are liberated, and recombinations occur with a higher frequency. However, in contradistinction to the behavior in higher organisms, in the phage some recombination, up to about 3 percent, occurs even between mutants belonging to the same functional group. Thus a map of the eight *rII* mutants shows that all the mutants of each group are located in a sequence adjacent to the mutants of the other group; but the recombination between the closest mutants of the two different groups is actually less than that between the most separated mutants belonging to the same group. Certainly mutants of the two distinct groups qualify as pseudoalleles, for they are functionally, as well as spatially, distinct. One is left in some doubt whether or not to call the mutants that belong to the same group and are functionally alike yet able to recombine, "pseudoalleles."

The study by Demerec and his coworkers offers one further conclusion of the most extraordinary interest. In *Salmonella* the combinations were made by transduction to determine the allelic relationships of 25 mutants, all of which require that cystine be added to the medium. When wild-type colonies are recovered by transduction between two different cystineless mutants, they may be regarded as functionally distinct. Three groups of mutants were found, corresponding to three different biochemical blocks in the series of steps from sulfate to cystine; and the arrangement of these three groups in the chromosome corresponds, it is said, to the sequence of biochemical steps. Such an arrangement implies a sort of assembly-line of genes in the chromosome working on successive steps in a single biochemical sequence. It is assumed that this arrangement has come about through duplication of a single original locus, followed by functional differentiation through mutation and natural selection, just as Stephens and others have suggested.

As to the gene—clearly when we have before us a process of continuous differentiation in the genetic material by means of pseudoallelism, the nature of the "gene" depends upon the stage in the process. A single biochemical unit, a segment, a repetitive sequence of identical units that can undergo recombination, or a sequence of functionally different pseudoalleles—the gene might be any of these up until the time when it has become clearly a multiplicity of genes.

BENTLEY GLASS
Mergenthaler Laboratory for Biology,
Johns Hopkins University,
Baltimore, Maryland

New AEC Division

The U.S. Atomic Energy Commission established a division of civilian application on 29 June. Harold L. Price was appointed director.

The new division takes the place of the division of licensing and carries out other civilian-use activities contemplated by the Atomic Energy Act of 1954, which encourages "widespread participation in the development and utilization of atomic energy for peaceful purposes."

The division is responsible for (i) developing AEC regulations and other instructions dealing with licenses, authorizations, and other activities related to civilian use, and providing for the issuance of these regulations and instructions; (ii) administering the AEC licensing program; (iii) developing pricing schedules for materials and services made available to licensees and prices to be paid by the AEC for materials produced or returned by licensees, and providing for the issuance of these schedules; authorizing the distribution of source, special nuclear, by-product, and other materials for licensed use; (iv) administering the AEC's program of access to restricted data for civilian use; and (v) handling authorizations to export equipment and materials or to engage in atomic energy activities outside the United States.

Radioactive Fallout in Great Britain

John Cockcroft, British physicist, reports [*Nature* **175**, 873 (1955)] that in Great Britain the average concentration of radioactivity in the air at ground level during the past 3 years owing to bomb explosions of all types is about 1 percent of the average natural radioactive dust content. The highest peak of activity was one-half of the average level. He states that the total expected human dose is 0.03 r, and 0.1 r in the United States where local fallout from Nevada is important. The radiation dose received by persons spending much of their time indoors will be reduced by a factor of at least 10.

Cockcroft cites H. J. Muller's consideration that doubling the natural mutation rate for several generations would produce disastrous results in a civilized population, and that it would be advisable to limit the dose received before reproduction to one-quarter of the doubling dose. He notes that the radiation dose required to double the natural mutation rate in mice is about 50 r, and that if the estimated safe limit of one-quarter of the doubling dose (12.5 r) per generation were taken, we are several thousand times below the maximum level.

Cockcroft concludes that "the level of radioactive contamination in the world produced by all the nuclear bomb explosions and peaceful atomic energy activities is at present so low that it should not cause any anxiety. The radiation-level which would give rise to serious harmful effects is at least a thousand times the present level of contamination. We do not at present know this figure with any accuracy, and long-term genetic studies are required to determine this."

For other data on human radiation dosages, see "Dosages from natural radioactivity and cosmic rays" by W. F. Libby [*Science*, **122**, 57 (8 July 1955)].—E. M. L.

Antarctic Observation Stations

The U.S.S.R. has told the organizers of the International Geophysical Year, in Paris, that it plans to occupy three outposts on the Antarctic Continent. These will be the first bases ever established by the Soviets in Antarctica, as far as is known. One station will be near the South Pole, a region in which the United States has already completed arrangements for a post.

Planning for new bases results from a conference in Rome last fall. At that time the nations that will participate in the International Geophysical Year, which begins 1 July 1957, met to discuss their program. One project calls for the establishment, by various nations, of Antarctic observation stations to study phenomena ranging from cosmic rays to weather. It was found that between the proposed stations there would be several gaps large enough to impair the results of the observations. Sites were proposed to close the gaps and participating nations were invited to fill them.

At the Paris meeting, which opened 6 July, the Knox Coast and the Princess Astrid Coast of Antarctica were the only two suggested spots that were still open. Australia, the U.S.S.R., Belgium, Japan, and the United States all expressed the desire to establish outposts on the Knox Coast, and the problem was referred to a working group for solution. The delicate matter of allocating base sites was resolved amicably, and it now appears that the United States and the U.S.S.R. will be the only countries to establish bases in that immediate area.

The following locations for Antarctic stations have been decided upon:

United States, 6 stations: Knox Coast, long. 110°E; McMurdo Sound; Kainan Bay (Little America); Marie Byrd Land; Vahsel Bay; South Pole.

Soviet Union, 3 stations: Knox Coast, long. 104°E; midway from there to the South Pole at long. 105°E; in the vicinity of the pole.

Britain and Argentina, Vahsel Bay; New Zealand, McMurdo Sound; Norway, on coast on the Greenwich meridian (probably in Byrd Bay); Australia, at Mawson on MacRobertson coast, and one station inland from that point; France, at Pointe Geologie in Adele Land, and one satellite station inland from there; Belgium, near Haswell Island at long. 95°E.

Japan, at the request of the conference, will occupy Peter I Island. There are also a number of permanent Argentine, British and Chilean bases on the Palmer Peninsula.

The U.S.S.R., Great Britain, and the United States all claim credit for the discovery of Antarctica, in 1821. Since then the Russians have not participated in exploration of the continent, although in recent years a Soviet whaling squadron has annually visited the Antarctic seas. The United States has not made a claim in Antarctica and does not recognize claims of other nations.

News Briefs

■ The Senate on 18 July passed by a unanimous voice vote a revision of S. Con. Res. 22, introduced 13 Apr. by Sen. Frederick G. Payne (R, Me.) and cosponsored by 27 other senators [*Science* **121**, 630 (29 Apr. 1955)]. The new version reads:

"RESOLVED, That the Senate endorses efforts of our chief delegate to the United Nations to take appropriate steps to work to establish within the United Nations procedures to receive, assemble, and report on radiological information collected by the various States with particular emphasis on radiation effects on human health and safety."

Payne, who was commended on the Senate floor for his initiative in this matter, said in explanation of the revision: "My substitute did primarily two things: It made the concurrent resolution a simple Senate resolution in order to give the Chamber most directly concerned with foreign affairs a chance to act finally on this matter before adjournment. It also revised the wording of the original resolution in order to make it more closely conform to the proposal of a similar nature made by Ambassador Henry Cabot Lodge in San Francisco on June 22, 1955."

■ The opening statement of an article in the 12 July *New York Times* reads:

"Dr. Luther H. Evans, director of the U.N. Educational, Scientific and Cultural Organization, said today (July 11) the agency would make a study of the world-wide peril of radioactivity as soon as the U.N. called for it."

Evans was in Brussels conferring with

Belgian government officials and addressing the second meeting of the World Brotherhood Conference, where he called for "an active role by the social scientists in analyzing the 'world's malaise' and cooperating in finding a cure for it."

At a news conference, Evans reported that UNESCO already had funds for a study of nuclear hazards and awaited only the signal from the U.N. He indicated that "More than half of a $45,000 appropriation could be used for such a work."

■ The Office of Scientific Research, which has been located at the Air Research and Development Command Headquarters since its establishment in 1952, will be set up as a separate activity and relocated in the Washington, D.C., area. The move is being made to increase emphasis on basic research and provide closer liaison with other research organizations.

The new office will be known as the Air Force Office of Scientific Research and will report directly to Thomas S. Power, commander of the Air Research and Development Command. Don Flickinger, at present director of research for ARDC, will be commander of the new office. William O. Davis will be deputy commander. In addition, there will be a civilian chief scientist and four civilian directors in the following fields: aerodynamics, materials, life sciences, and physical sciences. Although the organizational change will take place 8 Aug. 1955, the location of the office in Washington has not yet been selected.

■ Lewis L. Strauss, chairman of the Atomic Energy Commission, has announced that the AEC has formally determined that uranium-233 is special nuclear material. The determination will be effective upon publication in the *Federal Register*.

In accordance with section 51 of the Atomic Energy Act of 1954, the AEC's determination, together with the assent of the President, was submitted to the Joint Committee on Atomic Energy on 12 Apr. 1955.

In announcing the determination, Strauss said that it is designed to avoid a possible technical deficiency in the definition of special nuclear material contained in section 11 t. of the Act. Under this section, uranium enriched in the isotope 233 is one of the materials designated as special nuclear material. Unlike uranium-235, however, uranium-233 does not exist in nature and is not produced by enriching normal uranium in the isotope 233. The determination announced by Strauss will assure that uranium-233 is "special nuclear material," regardless of its method of production.

■ The Arctic Institute of North America has scheduled 22 field research projects for this summer, which will be supported by the Office of Naval Research, the Sir Frederick Banting Fund, and private contributors. The projects will be located at the Arctic Research Laboratory of the Office of Naval Research at Point Barrow, Alaska, and scattered throughout Alaska and northern Canada. Projects will include studies in geology, glaciology, biology, ornithology, soil formation, tundra vegetation, and hydrobiology.

Geophysical investigations will be concerned with disturbances in radio transmission, the relationship between auroral displays and disturbances in the earth's magnetic field, and studies of ground conductivity. An entomological project will attempt to locate the bedrock source of Alaskan amber as a means for studying cretaceous insects. The birds of the MacKenzie District, the marine flora of Ungava Bay, the hydrobiology of the Canadian Arctic Coast, and the waterfowl habitat in North America are other investigations included in this program.

Following is a list of the principal investigators: W. L. Boyd (University of Georgia); J. L. Chamberlin, A. M. Day, D. V. Ellis (McGill University); C. T. Elvey (Geophysical Institute, Alaska); C. J. Heusser (American Geographical Society); E. O. Höhn (University of Alberta); R. C. Hubley (University of Washington); Mrs. G. E. MacGinitie (California Institute of Technology); D. G. MacVicar (Yale University); B. E. Montgomery (Purdue University); R. M. Nardone (Catholic University); L. E. Nielson, F. A. Pitelka, R. L. Usinger (University of California); G. C. Ray, J. C. F. Tedrow (Rutgers University); E. B. Reed (Colorado A. & M. College); P. F. Scholander (Woods Hole Oceanographic Institute); R. E. Shanks (University of Tennessee); R. W. Wilce (University of Michigan); N. J. Wilimovsky (Stanford University).

■ A new instrument for measuring the effect of impact on metals and plastics has been developed in the Research Division of the New York University College of Engineering. The instrument, which is called the "impact tube," describes impact in terms of dynamic stress-strain relationships. In earlier instruments, stress-strain results have not been separated from the effects of waves propagated by sudden shock. In the new instrument the two elements are separated.

The impact tube consists, essentially, of a 14-ft-long steel tube 18 in. in diameter. It is divided into three chambers, a static chamber, a dynamic chamber, and a firing chamber. The test specimen, a circular metal plate, is mounted between the static and dynamic chambers. The other end of the dynamic chamber is sealed with a plastic diaphragm supported by a pneumatically controlled piston. Pressure is built up equally in the static and dynamic chambers. Impact is applied by a carefully controlled simulated explosion. First the diaphragm is ruptured. This sends an expansion wave from the mouth of the dynamic chamber to the specimen. Pressure at the specimen position drops in about 10^{-3} sec. The onrushing pressure from the static chamber slams against the specimen. This constitutes the impact loading.

With the new instrument, the effect of impact can be measured over the entire face of the specimen. Information is transmitted by pressure gages and transducers to an oscilloscope.

Scientists in the News

CHAUNCEY D. LEAKE, executive director of the University of Texas Medical Branch at Galveston and a member of the AAAS board of directors, has been appointed assistant dean of the College of Medicine and professor of pharmacology at Ohio State University, effective 1 Sept.

He will succeed JOHN A. PRIOR as assistant dean. Prior asked to be relieved of this position to devote his full time to teaching, research, and patient care in the department of medicine, in which he is a professor and director of the division of chest diseases.

RALPH R. SHAW, professor in the Graduate School of Library Service at Rutgers University, has been elected first vice president and president-elect of the American Library Association. Shaw is a member of the AAAS Publications Committee.

N. PAUL HUDSON has resigned as dean of the graduate school of Ohio State University, effective 1 Jan. 1956. After having served as dean for 9½ years, he will relinquish his administrative duties to return to the department of bacteriology, where he holds the title of research professor.

In addition to DHANVANTHI RAMA RAU [*Science* **120**, 823 (10 June 1955)], two other scientists received Lasker awards in planned parenthood: M. C. CHANG of the Worcester Foundation for Experimental Biology, and HOWARD C. TAYLOR, JR., chairman of the department of obstetrics and gynecology, Columbia University College of Physicians and Surgeons. Their citations read:

"To M. C. Chang—living proof that when East meets West in mutual respect and cooperation all humanity profits.

For over fifteen years he has been an amiable but indomitable exponent not only of scientific methods but also of emotionless accuracy in the interpretation and presentation of results. Indelible observation in his native land strengthened his drive to help release humanity from the biological slavery of uncontrolled reproduction. He has focused this energy through the lens of his own talents to illuminate the reproductive physiology of human beings. The results have brought man and woman substantially closer to more effective planning of their families, and thereby to more thoughtful control of their destinies."

"To Howard Canning Taylor—physician, scientist, teacher. As Chairman of the Committee on Human Reproduction of the National Research Council, he has taken a leading role in furthering knowledge of human fertility. As an educator, he has taught the care of child-bearing women to a generation of physicians. Long a friend of Planned Parenthood, his active participation in the councils of the Federation has added wisdom and dignity to its program and achievements. His work as a research investigator has advanced the science of medicine and contributed immeasurably to the reduction of maternal mortality and illness. He has taken important factors of fear and chance from the precious task of having babies, permitting parents to build their families less on anguish and accident, more on love and reason."

On 14 July the College of Physicians of Philadelphia awarded the 1955 Alvarenga prize to CHARLES H. RAMMELKAMP for his outstanding work in the field of streptococcic infections, particularly in relation to rheumatic fever and nephritis. The Alvarenga prize was established by the will of Pedro Francisco DaCosta Alvarenga of Lisbon, Portugal, an associate fellow of the college, to be awarded annually by the college on the anniversary of the death of the testator, 14 July 1883.

Three vice-presidential appointments have been made at Battelle Institute, Columbus, Ohio: B. D. THOMAS, DAVID C. MINTON, JR., and JOHN S. CROUT. All three have long been associate directors of the organization. Thomas is a physical chemist; Minton, a mining and metallurgical engineer; Crout, a mechanical engineer.

HIRSH W. SULKOWITCH, who is research physician for the Lahey Foundation, Boston, Mass., has been appointed scientific director of the Gray Pharmaceutical Co., Inc., of Newton, Mass. He will be responsible for all research, including the development of new products.

EDWIN H. CRABTREE, JR., deputy manager of the Grand Junction, Colo., Operations Office of the U.S. Atomic Energy Commission, was named director of the Colorado School of Mines Research Foundation, Inc., effective 1 Aug.

The board of directors of the Franklin Institute, Philadelphia, Pa., has announced the election of WILLIAM G. BATT as director of the Biochemical Research Foundation, Newark, Del. The institute has acted since 1935 as trustee for the foundation, which is devoted to cancer research. Batt, who has been associated with the foundation since 1937, became acting director in January 1955 upon the death of Ellice McDonald, director.

JOSEPH G. DAVIDSON, vice president of Union Carbide and Carbon Corp., New York, has been chosen to receive the 1955 Chemical Industry medal for "conspicuous services to applied chemistry." Formal presentation will be made in New York on 28 Oct. during a meeting at the Waldorf-Astoria Hotel of the American Section of the Society of Chemical Industry.

The following are among those who have recently received honorary doctoral degrees.

St. Olaf College: MARY B. STARK, former head of the department of embryology, histology, and neurology, New York Medical College and Flower Hospital.

Kalamazoo College: WILLIAM G. POLLARD, executive director of the Oak Ridge Institute of Nuclear Studies.

Berea College: RAYMOND MILLARD CABLE, professor of zoology, Purdue University.

CARL H. KRIEGER, director, General Laboratories, Wisconsin Alumni Research Foundation Laboratories, has been appointed director of basic research for the Campbell Soup Co., Camden, N.J., effective 1 Sept. In his new position Krieger will be responsible for directing projects in nutrition, the chemistry of flavors, and in fundamental research on ingredients.

ROGER WILLIAMS, an industrial scientist and this year's winner of the Perkin medal, is retiring as a vice president and member of the executive committee, of E. I. du Pont de Nemours & Co., Wilmington, Del. He will retain his position on the board of directors. SAMUEL LENHER, who recently was appointed a vice president and member of the executive committee, will replace him as adviser for the company's research activities.

Williams has been with Du Pont for 37 years. Among his accomplishments are contributions to the development of American production of synthetic ammonia and synthetic methanol and his guidance of the Du Pont Co.'s venture for the government into the production of atomic energy materials. During World War II he was in charge of Du Pont's Hanford Engineer Works. For his work on this project he received the Medal for Merit, the highest award the United States bestows upon a civilian.

Williams, who has held his present position since 1945, was born in Pottsville, Pa., 65 years ago. He was educated at the University of Nebraska and Massachusetts Institute of Technology. In 1914 he received a B.S. degree in chemistry from M.I.T., where he did graduate work in physical chemistry until 1916.

For the next 2 years he was a research chemist with the Nitrogen Products Co. Then in 1918 he joined Du Pont as a member of the chemical department's research staff at the Experimental Station.

When Du Pont entered the business of making ammonia synthetically in 1924 with the formation of Lazote, Inc., Williams was made chemical director of the new company. Lazote became the Du Pont Ammonia Corp. and later the ammonia department, which has since become the polychemicals department.

At an early date Williams foresaw the potential importance of nylon and instituted a program whereby the ammonia department was ready with satisfactory processes for the manufacture of nylon intermediates by the time the company undertook commercial production of the new fiber.

BRYCE L. CRAWFORD has been named chairman of the University of Minnesota school of chemistry. Sharing the administrative responsibilities will be STUART W. FENTON, assistant professor of organic chemistry, who has been appointed associate chairman.

Crawford, a member of the university staff since 1940, succeeds RICHARD T. ARNOLD. Arnold has resigned to join the Alfred Sloan, Jr., Foundation as director of basic research in physical sciences.

In the same school, WILLIAM N. LIPSCOMB has been named chief of the physical chemistry division. He succeeds ROBERT S. LIVINGSTON, acting division chief.

The following appointments to assistant professor have been announced. New York University: LISBETH M. KRAFT, microbiology (Berg Institute). West Virginia University: HAROLD OLAF LARSON, chemistry. Stanford University: RICHARD HARRIS PANTELL, electrical engineering; LAURENCE OSCAR PILGERAM, biochemistry; MARY VIRGINIA SUNSERI, mathematics; DONALD ROBERT YENNIE, physics.

Necrology

ABRAHAM JAMES CONNOR, Toronto, Canada, 71, retired chief climatologist of the Canadian Meteorological Service, 17 June.

ALBERT EDWARD CUMMINGS, New York, 61, director of research for Raymond Concrete Pile Co., 20 July.

MAXWELL J. FEIN, New York, 57, pathologist, founder of the Blue Shield movement in New York, 14 July.

AUSTIN FLINT, New York, 86, gynecologist, emeritus professor of obstetrics and gynecology at Bellvue Hospital Medical College, 20 July.

GEORGE A. GUTCHES, Washington, D.C., 72, retired Government forester and former professor of forestry at Syracuse University, 17 July.

AUBREY OTIS HAMPTON, Washington, D.C., 54, retired radiologist and wartime head of the radiology department at Walter Reed Rospital, 17 July.

AUBREY E. HOPKINS, Ocean Springs, Mo., 54, marine biologist, director of Gulf Coast Research Laboratory, 7 Feb.

CLINTON C. HOWARD, Miami, Fla., 71, retired head of the orthodontics department of Emory University Dental School, 16 July.

ABRAHAM KAUFMAN, New York, 72, pharmacist and trustee and member of the board of directors of Brooklyn College of Pharmacy, 17 July.

HENRY C. PILLSBURY, Ross, Calif., 74, former Army Medical Corps expert on x-rays, 18 July.

FREDERICK MARTIN SEBAST, Albany, N.Y., 63, head of the electrical engineering department at Rensselaer Polytechnic Institute, 15 July.

FRIEDA STRELITZ, New York, 59, research associate at New York Botanical Garden, 6 May.

Education

■ The University of California is establishing a cooperative engineering education program with Gadjah Mada University in Djakarta, Indonesia. Supervised by L. M. K. Boelter, dean of the College of Engineering on the Los Angeles campus, the program will be carried out under a contract with the International Cooperation (formerly Foreign Operations) Administration. The colleges of engineering on the Berkeley and Davis campuses will collaborate in the effort.

The ICA has negotiated an interim contract of $30,000 with the University of California to launch the undertaking. It is expected that this contract will be superseded by a full-term 2- to 3-year contract involving about $100,000 a year, financed by the ICA.

Thomas E. Hicks, associate professor of engineering at U.C.L.A., has left for Djakarta to make an initial survey with staff members of Gadjah Mada University. He will remain there for approximately a year as the first exchange professor in the program, teaching courses in chemical engineering.

This is the second ICA program in Indonesia organized by the University of California. The San Francisco Medical Center is carrying out an exchange program with the Medical School of the University of Indonesia.

■ The Berg Institute Scientific Services of New York University–Bellevue Medical Center, which procures and cares for all experimental animals used in the Medical Center, has opened a Laboratory for Study of Small Animals, under the supervision of L. Royal Christensen, director of the Scientific Services and associate professor of microbiology in the College of Medicine. The laboratory will be devoted to the investigation of diseases that affect animals used specifically for medical research.

Studies will be undertaken in such fields as infectious disease, genetics, epidemiology, and animal caretaker training. Starting next year, the laboratory will also conduct courses for the training of animal technicians.

■ In its census of foreign students in the United States for the academic year 1954–55, the Institute of International Education found that the most popular fields of study were engineering and the various branches of the humanities. Next came the social sciences, natural and physical sciences, medical science, business administration, education, and agriculture. The institute said that 34,232 students from 129 nations, dependent areas, trust territories, and international and military-government areas studied here. In addition to the students, there were 635 scholars serving on faculties here and 5036 physicians serving as interns or residents in American hospitals.

■ The Institute of Industrial Health of the University of Cincinnati has announced that a course in occupational skin problems will be given during the week of 10–14 Oct. It will be presented by the university's department of preventive medicine and industrial health in collaboration with the department of dermatology and syphilology and the Occupational Health Program of the U.S. Public Health Service.

The program will be divided into three daily sessions: morning lectures and clinical demonstrations; afternoon field instruction in industrial plants; and evening panel discussions. The didactic presentations will include a review of the anatomy, physiology, and chemistry of the skin. Detailed consideration will be given to the etiology, diagnostic evaluation, and treatment of occupational dermatoses as well as to specific measures for control of these problems. Current concepts regarding cutaneous cancer, allergic reactions, and medicolegal problems will be discussed.

Physicians interested in attending the course should write for an application blank to the Secretary, Institute of Industrial Health, Kettering Laboratory, Eden and Bethesda Avenues, Cincinnati 19, Ohio. Early application is advised, since attendance will be limited.

■ On 21 July Duke University's medical school and hospital, Durham, N.C., held an "appreciation ceremony" in commemoration of the 25th anniversary of the opening of the school and hospital. The university took occasion to pay public tribute to its veteran staff members for their long service, to the various professional groups whose cooperation has made the medical service possible, and to the many donors whose gifts have aided expansion.

The ceremony reflected the abiding aim of Duke Hospital and the medical school: to remain so consistently dissatisfied with the progress of medical care that what the university's president, Hollis Edens, has called a "healthy restlessness" will be imparted to all members of the staff and to medical people everywhere.

■ The University of Pennsylvania has awarded the major contract for the erection of a new astronomical observatory on a 31-acre site in Willistown Township, Pa., near Paoli. The observatory will combine the functions of the university's Cook Observatory, Wynnewood, and its old Flower Observatory, Highland Park, which was closed and sold last year because of glare, haze, and vibration.

The new facility will be called the Flower and Cook Observatory. The equipment will be housed in an L-shaped building. A movable aluminum dome, 27 ft in diameter, will be at the end of the longer arm of the "L." It will shelter a 28½-in. reflecting telescope. At the end of the other arm, a sliding roof will shelter a 15-in. horizontal telescope with a siderostat. Since the tube is stationary, it lends itself to the installation of electronic observation instruments. Both telescopes are now in the Cook Observatory.

The site, which was acquired several years ago, has the advantage of being on fairly high ground in a thinly populated area that is relatively free of smoke, glare, and vibration. It is about 20 mi west of the center of Philadelphia.

The university's department of astronomy will continue its research in the field of double and variable stars at the new observatory.

Grants, Fellowships, and Awards

■ The following types of fellowships, grants, and other appointments for research or study will be offered in 1956 by the Social Science Research Council, 726 Jackson Place, N.W., Washington 6, D.C.

Research training fellowships. Predoctoral and postdoctoral. For "more advanced research training than that which is provided in the usual Ph.D. program." All Ph.D. requirements except the thesis must be met before tenure of fellowship may begin, but application need not be deferred until that point has been reached.

Faculty research fellowships. Provide half-time support for research for 3-year terms. Open to college and university social science teachers. Ordinarily for those not more than 35 years of age.

Grants-in-aid of research. To aid scholars of established competence in meeting direct expenses of their own research projects. Not open to candidates for degrees.

Undergraduate research stipends. Open only to college juniors, for supervised research during the summer and the ensuing senior year. Some appointees will be granted first-year graduate study fellowships for the next year.

■ Sixteen new grants to American universities and medical centers will augment the extensive program of clinical and laboratory research in the fields of vitamins and nutrition of the National Vitamin Foundation, Inc. The foundation gives grants-in-aid semiannually throughout the United States and abroad. This group of awards, totaling $70,766, became effective on 1 July.

■ A grant of $13,200 has been awarded the West Virginia University School of Medicine by the Life Insurance Medical Research Fund. Designated for use during the period 1 July 1955–30 June 1957, the grant will support a research project on the role of epinephrine and related compounds in shock and hypertension, which is being conducted by Daniel T. Watts, head of the department of pharmacology. The department hopes to discover drugs that would block the adverse effects of epinephrine on the body.

■ Abbott Laboratories has set aside the sum of $2000, from which grants-in-aid will be made to suitable training courses or programs offered by recognized educational institutions and hospitals. Instruction must be of such a nature that it provides, in the course or as an adjunct thereto, the basic information and clinical experience required by the U.S. Atomic Energy Commission for the use of at least one isotope. Individual grants may be expended for the improvement of laboratory facilities, for the procurement of guest speakers, or in any other way the directors of the training programs may elect.

■ Grants by Sharp and Dohme to hospitals, colleges, universities, and other institutions for research and clinical studies have totaled $92,550 since 1 Aug. 1954, according to an announcement by the medical and research divisions of Sharp and Dohme, a division of Merck and Co., Inc.

■ The Multiple Sclerosis Foundation of America has presented $25,000 to the University of Chicago clinics for research on the causes of multiple sclerosis. The funds will be used to support work by Richard Richter, professor of neurology, and Eugene M. K. Geiling, professor and chairman of the university's department of pharmacology, who will attempt to locate within the nervous system, certain organic chemical compounds that have previously been injected into the blood stream. For this purpose, drugs and other compounds "tagged" with radioactive chemicals will be used. Some of these drugs are products of the university's "atomic farm," where drug plants are grown in atmospheres containing radioactive carbon dioxide. The compounds, which are to be studied in small laboratory animals, will include several drugs well known for their damaging effects on nervous tissues.

■ For the third consecutive year, the American Society for Metals will award $400 scholarships in metallurgy to 49 leading engineering schools in the United States and Canada, as part of a program sponsored by the society's foundation for education and research. The scholarship grant is paid to the university, whose department of metallurgy selects a winner on the basis of scholarship and financial need.

■ Gifts totaling more than $300,000 for educational grants to colleges and universities for the advancement of science and engineering are announced by the Dow Chemical Co. Allocations have been made to various institutions throughout the country for the academic year 1955–56.

A major phase of the aid-to-education program is the authorization of $133,500 for distribution to 38 colleges and universities for the establishment of graduate fellowships and undergraduate scholarships and to two educational foundations for use in assisting deserving students.

Another part consists of $167,500 allocated to 19 institutions, most of it earmarked for unrestricted use in current expansion and operating programs. The bulk of these contributions will go to Case Institute of Technology and to the Michigan College Foundation, in which 14 liberal arts colleges participate.

In addition to these grants, the company has assigned $140,000 for distribution to a number of schools for research on specific projects that supplement the company's own research in various fields.

■ The James Picker Foundation has announced the award of a grant to the Duke University School of Medicine in support of the studies of Robert J. Reeves on the effects of roentgen radiation on digestion and absorption of materials in the gastrointestinal tract. This grant was made on recommendation of the committee on radiology, Division of Medical Sciences, National Academy of Sciences–National Research Council.

■ Grants from the *Permanent Science Fund* of the American Academy of Arts and Sciences are made in support of research in any field of science whatsoever in amounts that ordinarily do not exceed $1500. Applications for grants to be made next March *should be filed by 1 Sept.* on forms available from the Chairman, Permanent Science Fund Committee, American Academy of Arts and Sciences, 77 Massachusetts Ave., Cambridge 39, Mass.

Special consideration will be given to projects on new frontiers of science, those that lie between or include two or more of the classical fields, those proposed by investigators who may be on the threshold of investigational careers or who are handicapped by inadequate resources and facilities. The committee does not ordinarily approve grants for research the results of which constitute partial fulfillment of requirements for an academic degree.

■ The application deadline for the 1956 American Heart Association research fellowships and investigatorships is *15 Sept.* Awards are made in the following categories:

Established investigatorships. Awarded for periods of up to 5 years, subject to annual review, in amounts ranging from $6000 to $9000, to scientists of proved ability who have developed in their research careers to the point where they may be considered to be independent investigators.

Research fellowships. Awarded to young men and women with doctoral degrees for 1- to 2-year periods to enable them to train as investigators under experienced supervision. Stipends range from $3500 to $5600.

The association also maintains another form of research support, the career investigatorship. This is awarded to a

limited number of investigators of unusual capacity and accomplishment to assure them of financial support throughout their productive lives. Career investigators are selected by the Research Committee from nominations, rather than by application of individuals. The selections are subject to approval by the AHA board of directors. The application deadline for grants-in-aid is *1 Nov.* Additional information and application blanks may be obtained from the Medical Director, American Heart Association, 44 E. 23 St., New York 10.

■ The United Brotherhood of Carpenters and Joiners of America has contributed $75,000 to insure the preservation of Mettler's Woods, a 65-acre tract of primeval forest near New Brunswick, N.J. The woods will be turned over to Rutgers University for administration, permanent protection, and use as a center for ecological studies.

A campaign to raise funds was begun 2 years ago by a citizens' committee headed by William H. Cole, director of the Rutgers University Research Council. More than 2000 separate gifts totaling $57,000 had been received prior to the union's donation. The woods, together with 71 acres of adjoining protective land, will stand as a memorial to William L. Hutcheson, late president of the union.

In the Laboratories

■ Ketay Limited is being formed by the Norden-Ketay Corp., New York, and the Plessey Co., Ltd., to design, develop, and manufacture synchro- and servomechanisms in England. Arrangements have been made to produce a complete range of sizes and types of these components.

Plessey, which has about 15,000 employees, is the largest European electronic and aeronautical component manufacturer. Norden-Ketay designs, develops and manufactures servomechanism components, instruments, computers, and automatic control systems in the nine plants and laboratories of its divisions and subsidiaries.

Ketay Limited has arranged for Plessey to provide the manufacturing facilities and manufacturing and administrative personnel; Norden-Ketay will provide engineering, design, and manufacturing information.

■ Hercules Powder Co. has announced plans to start immediate construction of a new plant at Louisiana, Mo., for the production of pentaerythritol (PE). Completion of the plant is scheduled for late next year. It will have an annual production of 24 million pounds of PE and 100 million pounds of formaldehyde, a basic raw material for PE. Pentaerythritol is used in paints, varnishes, lacquers, core oils, plasticizers, resins, and adhesives.

■ The Atomic Energy Commission has announced the award of a $349,560 contract to the Foster Wheeler Corp. of New York for the design, construction, and test operation of a research reactor at the commission's Livermore Research Laboratory, Livermore, Calif. The reactor, which has been designated the Livermore Pool Type Reactor, will be used by the University of California Radiation Laboratory at Livermore. The new unit is scheduled to be in operation by December 1956.

■ In line with Shell Chemical Corp.'s expanding activities in the synthetic rubber field, a manufacturing research unit has been established at the Torrance, Calif., plant. John Anderson, formerly research director at Shell Chemical's Houston Laboratory, will be research director at Torrance.

■ The first polymerization unit for the manufacture of synthetic resin emulsions in Colombia has just been shipped from Boston, Mass., to Medellin, where it will be erected. The Chemicals Export Co., which operates the export sales activities for the Polyco Department of the Borden Co., is sending the unit to its distributors, General de Productos Quimicos Fadales, S.A.

This firm will operate under a licensing arrangement with the chemical division of the Borden Co. for the manufacture of the Polyco synthetic resin emulsions. The new plant will polymerize a wide range of monomers, producing the Polyco chemical specialties used in the leather, textile, and adhesive fields.

Miscellaneous

■ A library of tape-recorded heart sounds and murmurs is being established by the American Heart Association for use in undergraduate and postgraduate medical education. The association's Committee on Auscultatory Phenomena announced that the library would include 10 teaching reels and 34 different heart sounds and murmurs available in loop form at two different speeds, 1⅞ in./sec and 7½ in./sec.

The tapes are expected to be ready for circulation about 1 Sept. Information on use of the tapes, as well as descriptive materials on their content, can be obtained from the Medical Division, American Heart Association, 44 E. 23 St., New York 10.

■ The Brookhaven National Laboratory has prepared a completely new edition of its book of cross sections, *AECU-2040*, which will be known as *Neutron Cross Sections BNL-325*. It will be put on sale this month by the Government Printing Office, probably at a price of $3.50. Included with it will be an addendum containing the cross-section results for the important heavy elements from all the countries that are presenting such data at the Geneva nuclear conference, including the Soviet results.

■ In accordance with the President's Executive Order of 9 May, on 1 July the former Foreign Operations Administration became the International Cooperation Administration and was established as an agency within the State Department. John B. Hollister, who served as executive director of the Commission on Organization of the Executive Branch of the Government (the Hoover Commission), is director of the new agency.

■ The U.S. National Museum, Smithsonian Institution, recently opened an exhibit illustrating Indian life among the historic tribes of Latin America. A notable part of the exhibit is a reconstruction of a Lucayan-Arawak village on the present Long Island in the Bahamas, called Fernandina Island by Columbus. The settlement, one of those described in some detail in the discoverer's journal, was on approximately the site of the present small village of Burnt Ground.

The reconstruction was made on the basis of Columbus' description and the archeological work of the Ernest N. May-Smithsonian expedition of 1947. Before directing this reconstruction, museum ethnologists made an extensive study of all records available from the late 15th and early 16th centuries.

In addition to the West Indian material, the new exhibit includes a display of the head-shrinking techniques of the Jivaro Indians of the Ecuadorian jungles, a hunting camp of the Yahgans of Tierra del Fuego, and 17 other features.

■ The first article in the August issue of *The Scientific Monthly* is "What's happening to our glaciers!" by William A. Long. The other articles include "Our responsibilities as scientists," J. Rud Nielsen; "Karl Wilhelm Feuerbach, mathematician," Laura Guggenbuhl; "Lettuce industry of the Salinas Valley," Paul F. Griffin and C. Langdon White; and "Medals of the Royal Society of London," Erwin F. Lange and Ray F. Buyers.

In the "Science on the march" section, there is a discussion of the forthcoming International Geophysical Year, by Harold Spencer Jones. This issue also contains the reviews of 16 books.

Reports and Letters

Behavior Pattern in Migratory Fishes

I wish to call attention to a behavior pattern in certain migratory fishes which may be a very common phenomenon. So far the evidence for its universality is relatively slight, yet there are indications that it may be both widespread and of some importance to the economy of the affected species. The hypothesis may be stated as follows: In anadromous or potamodromous (*1*) fishes the earliest arrivals in a particular spawning tributary will travel to the farthest reaches of the acceptable breeding area, the later arrivals occupying territories closer to the mouth of the stream.

My first awareness of this type of behavior came when I was working on a small coastal stream in California (*2*) and I referred to it, for want of a more concise terminology, as a "phenomenon of differential distribution." Since that time attempts have been made to collect further information, both from the literature and through correspondence with persons engaged in research on the life-cycles of such fishes.

Stone (*3*) and Hobbs (*4*) both noted that the earlier runs of king salmon (*Oncorhynchus tshawytscha*) go farther upstream and that the later fish take places below them. In 1939, Pritchard and Cameron (*5*) observed the distribution of tagged sockeye salmon (*O. nerka*) in a small creek but found no significant correlation between the location on the spawning areas and the time of entry into the stream. In this case it may be that the presence of a weir, which would somewhat delay the spawning run, and the handling of adults during the tagging process had some effect on their subsequent distribution. It is interesting to note that a report by Schaefer (*6*), also describing work with the sockeye salmon, does refer to a differential distribution on the spawning grounds.

During his observations on the life-history of the sea lamprey (*Petromyzon marinus*), Applegate (*7*) found a well-marked differential distribution. The most recent observations (*2*) of this phenomenon were made on the Pacific lamprey (*Entosphenus tridentatus*), the silver salmon (*O. kisutch*), and the steelhead trout (*Salmo gairdneri*). Briefly, the results of communication with other biologists have been encouraging because many have mentioned casual observations which tend to show that this distributional pattern is repeated, at least occasionally, in other areas and with other migratory species such as the eastern brook trout (*Salvelinus fontinalis*) and the Atlantic salmon (*Salmo salar*).

As is stated in a foregoing paragraph, the hypothesis is given as a possibly typical behavior, but I recognize that a number of situations might exist which would so modify the effect of this behavior that its expression may be more or less inhibited. These are some factors that must be taken into consideration when observations are made for the purpose of testing this hypothesis: (i) The breeding area of a particular stream may be cut off or otherwise affected by dams, log jams, or waterfalls. (ii) An unsuitable spawning substrate might be present over a portion of the area. (iii) Local pollution or unfavorable temperatures may have noticeable effects. (iv) The behavior may not be shown by species that typically spawn very close to salt water or in brackish situations. (v) There might be a great range in size in a particular species, so that the larger individuals would be inclined to seek deeper water for spawning purposes.

The most logical explanation of why such a phenomenon should exist is that it is genetic in nature and such early arrivals are offspring of parents that showed a similar behavior. The principal objection to this theory is that there are certain selective disadvantages operating against such a state of affairs. The fishes that spawn earliest (at least in some species) travel upstream under conditions of relatively low water, with the result that passage is more difficult, and are, presumably, under greater threat from predatory animals. However, this disadvantage may be offset by the favorable conditions that are found by the young upon their emergence. They would have a headstart over the progeny of the later arrivals, an especially important factor in such fishes as salmon or trout, which are quite cannibalistic.

In some Pacific salmon another cause may lie in the territorial behavior of the female. Once the territory is selected and the spawning activities are begun the female becomes a very zealous guardian and remains so for a considerable period after the eggs are deposited. This may discourage later females from penetrating farther into the spawning area, especially if the stream is small. On the other hand, territorial behavior is only poorly developed in the steelhead trout and the sea lamprey, and, as was mentioned previously, these two species have been observed to follow the differential distribution pattern.

This "rule" of behavior is presented here as a hypothesis, one that does seem likely in view of the information obtained so far. It is hoped that its publication will stimulate the curiosity of those engaged in research on the life-histories of migratory fishes.

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References and Notes

1. The terms *anadromous* and *potamodromous* are used according to the restricted definition of G. S. Myers [*Copeia* **2**, 94 (1949)]: *anadromous* refers to marine fishes that migrate to fresh water to breed, and *potamodromous* means those fishes that migrate wholly within fresh water.
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7 June 1955

Concentration and Purification of Polio Viruses

Methods have been developed recently that employ heavy metals in the separation of various components of plasma (*1*). These techniques have been utilized in the concentration and purification of influenza and Rous sarcoma viruses (*2*). We have applied modifications of these methods to the concentration and purification of polio viruses. Highly significant results have been obtained, and since vaccines made from these agents currently occupy much attention, a brief mention of our results appears to be timely.

Polio viruses types I, II, and III grown in monkey kidney cells in 199 medium have been quantitatively precipitated by the addition of zinc lactate to a concentration of 2.5 to 5 mmoles/lit at *p*H 7.5. All manipulations are carried out at 2°C. The precipitate (which contains greater than 99 percent of the virus) is separated at about 3000 rev/min in the refrigerated angle centrifuge. The insoluble zinc-virus compound is washed at various *p*H levels with reagents such as 0.85-per cent NaCl

or H_2O. The zinc may be removed by adding a small amount (1 to 100 ml) of 0.1*M* sodium citrate to the zinc-virus compound followed by dialysis against H_2O or 0.85-percent NaCl. An alternate method is the removal of zinc utilizing ion-exchange resins (*3*). Analyses show that either dialysis or resin exchange will remove zinc to a residual concentration of less than $2 \times 10^{-5}M$.

Titration of the virus concentrate in monkey kidney tissue culture demonstrates that no loss of virus occurs. The titers expressed in infective units for dose $\log_{10}$ of type II MEF_1 virus before zinc precipitation, and of the supernatant after zinc precipitation were $10^{7.7}$ and $10^{4.2}$, respectively, and of type III Saukett were $10^{5.5}$ and $10^{1.5}$, respectively, or approximately 99.9 percent of the virus was removed. The stability of the zinc precipitate has been followed for 10 wk at 4°C without perceptible loss of infectivity for monkey kidney tissue culture. (It is interesting to note that the titer of the virus is unaltered even when zinc is combined with it.)

The method described here has many obvious applications. It provides a technique for safety testing of the finished vaccine, since any desired concentration may be effected. The process provides a simple way of removing various components of the medium, such as antibiotics, amino acids, and metabolites. It should simplify the production of the vaccine, since large volumes of virus may be conveniently and rapidly concentrated for processing and killing. This should make possible better standardization of virus inactivation with formaldehyde on other agents. With the removal of the growth medium, selection of a preservative and antigenic stability of the vaccine may no longer be a problem.

The method would appear to have wide application. Highly purified, stable herpes simplex virus has been obtained (*4*).

A complete report concerning work with poliomyelitis viruses is in preparation.

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23 May 1955

Some Analogs and Derivatives of the Insecticide DDT

A casual inspection of recent chemical literature reveals that no fewer than 102 organic compounds, either isomeric or analogous DDT [1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane], have been prepared. An inclusion of related condensation products would provide even a far more imposing list. We have recently prepared five additional analogs of DDT that have not been previously reported (*1*). In connection with the preparation of these five compounds, a more exhaustive study has been made of several other variations.

The general method of preparation consisted in the condensation of chloral hydrate, bromal, or butyl chloral with several mono- or disubstituted benzenes in the presence of fuming sulfuric acid. In several instances, the resulting compounds were subsequently treated with alcoholic potassium hydroxide in order to eliminate hydrogen halide. These ethylenic products were then further halogenated or oxidized to related derivatives. Various nitro derivatives were also prepared by the direct nitration of the original condensation products. The results of 33 types of attempted condensations under a variety of conditions that involved several hundred syntheses seemed to indicate that chloral hydrate and monohalogenated benzenes condense readily in the presence of fuming sulfuric acid. Bromal and monohalogenated aromatic compounds formed condensation products that were, in general, relatively unstable, as was previously reported (*2*). Butyl chloral and chlorobenzene formed condensation products of unknown and variable structure. Ethyl benzoate and chloral hydrate formed an apparent condensation product that was unstable to treatment with alkali. The condensation of chloral hydrate with *p*-dichlorobenzene, *p*-dibromobenzene, and *p*-chlorobromobenzene formed products, the structure of which has not been fully established. *m*-Dichlorobenzene, *o*-dichlorobenzene, and *o*-chlorotoluene did not condense readily with chloral or its hydrate under comparable conditions using fuming sulfuric acid.

The specific experimental data in the preparation of these analogs is as follows.

1) 1,1-Dichloro-2,2-bis(*p*-iodophenyl)-ethylene: A mixture of 10 g of 1,1,1-trichloro-2,2-bis(*p*-iodophenyl)ethane (*3*) and 6 g of potassium hydroxide in 400 ml of 95-percent ethanol was refluxed for 4 hr. The reaction mixture was poured into ice water, filtered, and recrystallized from absolute ethanol, yielding 4.8 g (51-percent theory) of product; melting point, 146.4 to 147.0°C (corrected). As proof of structure, this compound was oxidized with chromium trioxide in glacial acetic acid to *p*-*p*′-diiodo benzophenone; melting point, 235° to 236°C (*4*).

2) 1,1,1-Trichloro-2,2-bis(3-nitro-4-iodophenyl)ethane: A solution of 10 g 1,1,1-trichloro-2,2-bis(*p*-iodophenyl)-ethane in 160 ml of glacial acetic acid and 160 ml of fuming nitric acid (specific gravity, 1.60) was heated on a steam bath for 5 hr. The resulting nitrated product was poured into ice water, filtered, and recrystallized from absolute ethanol, yielding 5 g (45-percent theory) of product; melting point, 173.7° to 174.3°C (corrected). It was assumed that one nitro group entered the 3-position *o*- to the iodine. Analytic calculated for $C_{14}H_7Cl_3I_2N_2O_4$: N, 4.46 percent; found: 4.52 percent.

3) 1,1,1,2-Tetrachloro-2,2-bis(*p*-bromophenyl)ethane: A warm solution of 20 g of 1,1,1-trichloro-2,2-bis(*p*-bromophenyl)ethane (*5*) in carbon tetrachloride was chlorinated with strong illumination during 4 hr. The carbon tetrachloride was removed by vacuum distillation, and the solid was recrystallized from absolute ethanol, yielding 12 g (57-percent theory) of product; melting point, 95° to 96°C. Theoretical silver halide for $C_{14}H_8Cl_4Br_2$: 1.980 g/g of compound; found: 2.018 g/g of compound.

4) 1,1,1-tribromo-2,2-bis[2(5)-chloro-5(2)-bromophenyl]ethane: A 1.0- to 2.0-mole ratio of bromal and *p*-chlorobromobenzene was heated at 85° to 90°C while 400 ml of 15-percent fuming sulfuric acid was slowly added with vigorous stirring. The reaction mixture was heated for an additional 2 hr at the same temperature, resulting in the formation of a yellow precipitate. The product was filtered and then washed, first with 10-percent sodium bicarbonate solution and then with water. After recrystallization from a 50–50 mixture of ethanol and trichloroethylene, followed by absolute ethanol, 50 g (50-percent theory) of a yellow product was obtained, melting point, 163.0° to 163.7°C (corrected). Theoretical silver halide for $C_{14}H_7Cl_2Br_5$: 1.898 g/g of compound; found: 1.895 g/g of compound. We are inclined, in the light of orientating tendencies and steric hindrance, to assume that the coupling in the phenyl group is *o*- to the chlorine and *m*- to the bromine, although the converse might be true. Final confirmation on this structure is still lacking.

5) 1,1,1-Tribromo-2,2-bis(2,5-dibromophenyl)ethane: A similar condensation was made with a 1.0- to 2.0-mole ratio of bromal and *p*-dibromobenzene that was heated with 720 ml of 15-percent fuming sulfuric acid and stirred at 75° to 80°C for 2 hr. The brown prod-

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uct was filtered and then washed, first with 10-percent sodium bicarbonate solution and then with water. After crystallization from a 50–50 mixture of ethanol and trichloroethylene, followed by recrystallization from ethanol, a 140-g yield (19-percent theory) was obtained; melting point, 179.8° to 180.6°C (corrected). Analytic calculated for $C_{14}H_7Br_7$: Br, 76.15 percent; found: Br 76.87 percent.

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18 April 1955

Intracellular Symbiosis in Cockroaches: II. Mitotic Division of Mycetocytes

In part I of this series, we describe the histology, slow growth, and poor reproductive performance of aposymbiotic German cockroach nymphs (*Blattella germanica* L.) (*1*). These were produced by continuously feeding their parents Aureomycin, an antibiotic that prevents the ovarial transmission of the symbiotes (bacteroids). In connection with that work, stained serial sections of a few normal control roaches showed various stages of mitosis among the mycetocytes (the symbiote-containing cells of the fat body, Fig. 1.) Figures 4 and 5 are photomicrographs of representative dividing mycetocytes. Such cells arrested our attention (*2*), because the failure of earlier authors to find mitosis had suggested that the mycetocytes increase by amitosis during nymphal growth (*3*).

The division of the mycetocytes was synchronized so that numerous mitotic figures were distributed throughout the entire abdomen of all nymphs showing mitoses. In most nymphs, no divisions were seen. Bursts of mitotic activity are known in other organisms, so we made a series of preparations of nymphs of known ages to see whether the bursts were correlated with the molting cycle.

Under our rearing conditions, nymphs molt approximately every 10 or 11 days, passing through six molts and maturing at about 60 to 65 days. A total of 80 nymphs, ranging from newly hatched to 40 days, most of them in the second instar, were sectioned and stained. All of the sections of the abdomens were inspected. Counts were made of nymphs with the most easily recognizable stages —that is, metaphase and anaphase. A total of 14 nymphs showed mitotic mycetocytes on the 9th, 16th, 18th, 20th, 30th, and 40th days. In the second instar, of 14 nymphs between the ages of 11 to 14 days, inclusively, there were no mitoses; while of 24 nymphs between the ages of 16 to 20 days, inclusively, there were 10 with mitoses.

It was clear that mitosis occurs in bursts in the latter half of the instar. Frequently mitosis in the mycetocytes was accompanied by mitosis in the mid-gut epithelium and in other cells of the fat body, either urate- or fat-cells (indistinguishable in young nymphs). Divisions were not noticed in the epidermis. Undoubtedly mitosis has escaped previous detection because it occurs in nymphs of an age not usually studied.

Mitotic processes were also seen in mycetocytes and other fat-body cells in nymphs of the wood roach, *Parcoblatta pennsylvanica* (DeGeer), which had been collected while they were hibernating in February and kept active in the laboratory until they were sacrificed in June.

Mycetocytes differentiate in aposymbiotic embryos—that is, in embryos developed free of bacteroids. These "empty mycetocytes" are present as clusters of cells with large nuclei and small amounts of fibrous-appearing cytoplasm devoid of bacteroids (Fig. 2). There are 10 clusters, one in each lateral half of abdominal segments 2 through 6. The positions of the empty cells are the same as the positions of the mycetocytes, which in normal embryos are formed in anticipation of their infection by the bacteroids (*3*). The empty mycetocytes were never seen dividing. Seemingly, without the pressure of a growing population of bacteroids, the mycetocytes lack the stimulus to divide and separate; thus they remain in clusters and at their original number.

An interesting contrast to the empty mycetocytes was the behavior of certain bacteroid-containing mycetocytes that grew to gigantic proportions in other experimental roaches. Serial sections of various developmental stages following short Aureomycin treatment (*1*) showed that some individuals were deficient only in bacteroids; that is, they were semi-aposymbiotic. Only a small fraction of the normal complement of bacteroids had been transmitted to the nymphs; these bacteroids were present as subnormal populations in the cytoplasm of just a few mycetocytes. The few mycetocytes eventually grew, by the end of 9 wk, to about 200 times the normal volume instead of dividing (Fig. 3). Perhaps this

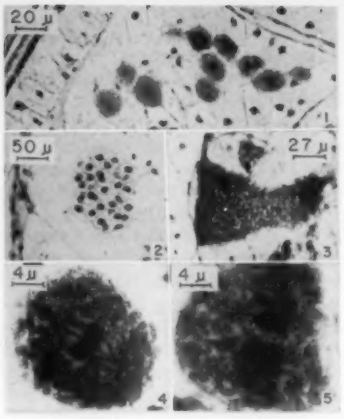

Fig. 1. Part of a cross section of a 2-wk old normal nymph showing distribution and size of mycetocytes. Fig. 2. Part of a cross section of a 2-wk old aposymbiotic nymph showing one cluster of empty mycetocytes. Fig. 3. Section through a giant mycetocyte in a 9-wk old retarded nymph. Figs. 4 and 5. Photomicrographs of sections through mycetocytes whose nuclei are undergoing mitosis. The bacteroids are so numerous that the spindle fibers are almost obscured. The bacteroids look hollow as a result of the fixing and straining procedure. All material was fixed in Carnoy's fluid, sectioned at 10 μ, and stained with Delafield's hematoxylin, counterstained with erythrosin in clove oil.

phenomenon may be accounted for by a postulated lack of a dividing stimulus, correlated with an inadequate bacteroid population when the cells were young and ordinarily would have undergone division. There seemed to be no check on the multiplication of the bacteroids.

We conclude that mitosis is the normal means of division in mycetocytes and that it occurs in bursts near the end of each instar. If only a few bacteroids are present originally, the bacteroids increase but the mycetocytes do not divide, whereas if bacteroids are absent the mycetocytes remain small, in clusters, and do not divide.

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23 March 1955

Paper Electrophoresis with Superimposed pH Gradient

Kolin (*1*) has recently reported a new technique of free-boundary electrophoresis in which a *p*H gradient is superimposed on the potential gradient. The components of a mixture separated by this technique assume an order according to their isoelectric points. In the present paper, the use of *p*H gradients in paper electrophoresis is described (*2*).

Figure 1 shows protein patterns after electrophoresis by the conventional technique and in a *p*H gradient; Whatman No. 3 filter paper mounted horizontally and bromophenol blue stain (*3*) were used. Patterns *a* and *b* were obtained with Veronal buffer of ionic strength 0.05 and *p*H 8.6 after 3.5 hr at 200 v across the electrodes (exposed length of paper strip 21 to 23 cm, sample applied near the end of the strip). In experiments *c* and *d*, a *p*H gradient was established by wetting the paper strip from the side of the positive electrode with 0.05*M* NaH_2PO_4, which has a *p*H of about 4.3, and from the other side with 0.01*M* phosphate buffer solution of *p*H 7.4. The sample was then applied as a streak along the line where the two phosphate solutions met, and 200 v was applied for 6.7 hr.

Staining with Sudan Black B (*4*) showed that the largest amounts of lipid, usually associated with beta-lipoprotein, were located at or behind the beta-globulin protein band in Veronal, but in the patterns obtained with the *p*H gradient they were located at the front edge of the component (marked 2), which was provisionally identified with beta-globulin. In both techniques, the lipid of the chylomicrons remained at the site of application of the sample, and small amounts of lipid were found in the albumin region on the side toward the globulins ($alpha_1$-lipoprotein).

Although the two methods should not be expected to yield exactly the same distribution of the components, analysis of the eluates (0.01N NaOH) from sections of the paper strip (Table 1) gave fair agreement when it was assumed that component 1 corresponds to $alpha_2$-globulins, component 2 to beta-globulins, and component 4 to gamma-globulins. Fibrinogen was contained in component 3. The discrepancies in the values for albumin plus $alpha_1$-globulin may be attributed to the trail observed in Veronal at *p*H 8.6 between the beta-globulin and the origin, if it is assumed that all of this trail is caused by albumin. In electrophoresis in Veronal, the trail on the gamma-globulin may be obviated by placing the sample at the center of a longer paper strip, whereupon the gamma-globulin moves backward. The example in Table 1 is quoted to demonstrate the extent of possible error as a result of trailing. The band of component 1 in the plasma pattern analyzed included the material that was irreversibly adsorbed at the site of application, and this may have been the cause of the low value for plasma component 3. In the patterns shown in Fig. 1*c*, *d* the material at the site of application was included in component 2.

The movement of a band depends on the mobility of the protein and also on the rate of flow of the buffer solution, which in turn depends on the rate of evaporation of solvent and the position on the strip. The flow is greatest at the ends of the paper strip that dip into the buffer solutions and is zero approximately in the center. The flow pattern can be regulated by varying the concentrations of the two buffer solutions used.

Whenever the electrophoretic migration velocity of a material is equal and opposite to the flow of the buffer solution, the band will remain stationary (*3*). Macheboeuf (*5*) has realized that this property can be used, among other applications, for the electrophoretic study of very dilute solutions without previous concentration, since all the material applied collects in narrow bands at the appropriate positions of zero velocity. Macheboeuf regulated the evaporation of the solvent by means of holes in the hood that covered the filter paper strip. In both methods employed by us the strips were kept under closed hoods. Nevertheless the rate of evaporation of solvent from the paper was large enough to aid in sharpening the bands.

Figure 1*e* shows the pattern of the plasma of *b* and *d* analyzed with the *p*H gradient after 1-to-20 dilution with 0.01*M* phosphate of *p*H 7.4. The colorimetric values of the components of a 1-to-20 diluted serum agreed within 1 percent of the total optical density with those obtained with undiluted serum, except for the band No. 2. This band contained the site of application in the case of the undiluted serum, and the percentage value for this component was 2.0 higher than that for diluted serum.

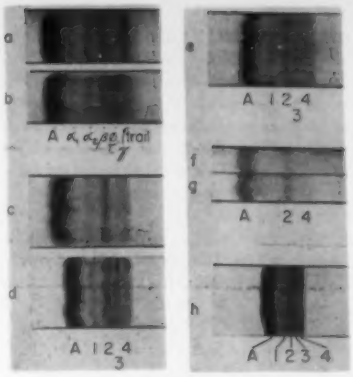

Fig. 1. Electrophoretic patterns of human serum (*a*, *c*), plasma (*b*, *d*, *e*, *h*), and cerebrospinal fluid (*f*, *g*); *a* and *b* obtained by conventional technique, all others in a *p*H gradient.

Still more attenuated conditions with regard to the concentrating effect were present in two experiments with unconcentrated cerebrospinal fluid that contained 0.01 (Fig. 1*f*) and 0.02 (Fig. 1*g*) grams of protein per 100 ml, respectively. On the narrower strip 0.8 ml cerebrospinal fluid was used.

The sharpness of the bands can be improved at the expense of the extent of the pattern by increasing the buffer salt concentration (Fig. 1*h*; 0.08*M* NaH_2PO_4 and 0.01*M* phosphate at *p*H 8; 6.7 hr at 200 v). Since the salt concentration on the paper strip increases continually, the pattern of the separated proteins narrows slowly on prolonged electrophoresis. There is, therefore, an optimum time for the greatest separation of the components.

The separation of proteins whose isoelectric points differ little—for example, hemoglobins A and F—could not be achieved by *p*H-gradient paper electrophoresis. The bands overlapped to a similar extent whether the *p*H gradient was steep or flat. It is possible to separate such components by electrophoresis at a single *p*H if the operation is carried on

Table 1. Analysis of serum and plasma proteins by the *p*H-gradient method (in percentage of total optical density at 595 mμ).

Method of analysis	Serum		Plasma	
	*p*H gradient	Veronal, *p*H 8.6	*p*H gradient	Veronal, *p*H 8.6
Albumin	71.8	60.1	67.5	56.6
$alpha_1$-		4.8		5.3
"1" or $alpha_2$-	7.3	7.8	10.5*	6.9
"2" or beta-	11.7†	11.0	10.3	9.9
"3" or tau (+ fibrinogen)	1.9	3.2	5.7	12.5
"4" or gamma-	7.3	11.7	6.0	8.1
Trail at rear of gamma-		1.4		0.7

* Includes some particulate matter staining at site of application.
† Includes little particulate matter staining at site of application.

for a sufficient length of time. The *p*H-gradient method is particularly useful for the analysis of very dilute solutions and appears to offer advantages over Macheboeuf's electrorheophoresis (*5*) because of its flexibility in directing the displacements of the bands and because of its avoiding excessive concentration of buffer salt on the paper.

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8 April 1955

Direction of Ionic Addition to Olefinic Double Bonds

When the addition of an unsymmetrical molecule to an olefinic double bond begins with addition of a cation to the pi electrons (*1*), the direction of the addition can be simply explained, without the concept of hyperconjugation (*2*) or the assumption of polarity in the double bond (*3*). The cation tends to become finally joined to that one of the two unsaturated atoms from which an electron is less readily removed, except where this effect is overcome by electrostatic forces. As a general principle, two factors appear to control the ease of withdrawing an electron from an atom. One is the partial charge on the atom: the less positive and more negative the charge, the greater the ease of electron withdrawal. The other is the nature of attached atoms and groups: the more readily these atoms can supply charge to compensate for the withdrawal, the greater is the ease of withdrawal.

The fundamental basis for the proposed explanation is information on charge distribution obtained by methods recently described (*4*). It is possible to estimate what the partial charge on each atom of a molecule would be, if the only factor were the initial electronegativity differences and the process of equalization during combination (*5*). Similarly, the effect of adding a cation to a double bond may be estimated, assuming that the principle of electronegativity equalization is valid here. The detailed application of such partial charge information can best be illustrated by examples.

Consider an olefinic bond in an alkene. According to the theory, such a bond must always be electrically symmetrical (nonpolar), because an alkyl group contributes exactly the same partial charge to an unsaturated carbon as does hydrogen. However, alkyl groups are potentially more capable of contributing negative charge (are better reservoirs). When a cation—for example, a proton from CHl—adds to the pi electrons of an unsymmetrical olefin like propene, the charge may be considered as becoming distributed throughout the resultant carbonium ion by an adjustment of bond polarities, causing in effect an electron flow toward the adding proton. The partial charges on carbon and hydrogen in propene are -0.040 and 0.020 electron. In the carbonium ion they would be 0.055 and 0.119. The charge of 0.881 contributed to the proton would come 0.293 from the CH_2 side of the double bond and 0.586 from the CH_3CH side.

In order that a cation become finally attached by a covalent bond to one of the originally unsaturated carbon atoms, one of the electrons for the bond must be removed entirely from the other carbon. This removal quite logically can occur more readily from the carbon that has the greater reservoir of charge. As is indicated by the afore-mentioned relative charge contributions, this carbon is the center one of propene. The proton, accordingly, becomes permanently attached to the more hydrogenated carbon of the double bond. This leaves the central carbon with an unoccupied orbital, a ready acceptor of an electron pair of the chloride ion. Markownikoff addition to other unsymmetrical olefins may be explained similarly.

The opposite mode of addition may occur when a strongly electron-withdrawing group is attached to the side of the double bond that otherwise would be expected to serve better as an electron reservoir. The inductive effect of this group makes the removal of an electron from the unsaturated carbon nearer it more difficult. Hence, the cation becomes attached to this carbon, and the anion adds farther from the electronegative group. For example, in the α,β-unsaturated acid, CH_2=CHCOOH, each hydrogen bears a charge of 0.102 and each carbon, 0.042. Addition of a proton to the pi electrons would result in a carbonium ion in which a contribution of 0.803 electron would be made to the adding proton. The electron-withholding action of the oxygen prevents the central carbon from contributing more than 0.278, leaving 0.524 to be contributed by the CH_2 group. Accordingly, the proton here becomes attached to the less hydrogenated center carbon, and the adding anion joins the unsaturated carbon farther from the carboxyl group.

On the other hand, an electron-releasing atom such as silicon has the effect in an olefin that the adding cation becomes attached to the carbon farther from this atom. This occurs, for example, in hydrogen halide addition to $(CH_3)_3Si$—CH_2—CH=CH_2 (*6*).

Major exceptions to addition as explained in the foregoing paragraphs result when an atom attached directly to an olefinic carbon bears a relatively high partial charge. Then the electrostatic effect on the pi electrons appears dominant. One illustrative example is addition to vinyl chloride, CH_2=CHCl. Electrons should be more available from the CH_2 than from the CHCl. Explained on this basis, an adding cation should become attached to the chlorinated carbon. However, the partial charge of -0.238 on the chlorine appears sufficient to repel the pi electrons, making them actually more available at the opposite carbon. The double bond is thus permanently polarized, and it is the anion that becomes attached to the chlorinated carbon. An opposite illustration is the example of HCl addition to $(CH_3)_3Si$—CH=CH_2. Despite the electron-releasing action of the silicon, the addition is non-Markownikoff (*7*) and the proton becomes attached to carbon next to silicon. Evidently the dominant effect is the attraction of the pi electrons by the silicon, with its partial charge of 0.273.

None of the afore-mentioned factors is likely to be completely dominant except in extreme instances. The explanations offered are therefore intended to account for principal trends only.

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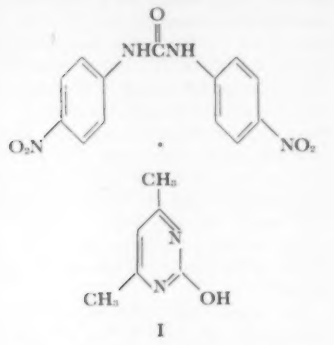
16 May 1955

Antiparasitic Activity of Substituted Carbanilide Complexes

As part of an investigation of the therapeutic potentialities of aryl ureas, we have observed that molecular complexes of certain substituted carbanilides possess antiparasitic activity. In particular, several of these complexes have shown significant activity in avian coccidiosis. The complex (I) of 4,4′-dinitro-

carbanilide (DNC) and 2-hydroxy-4,6-dimethylpyrimidine (HDP) was found to be among the most effective.



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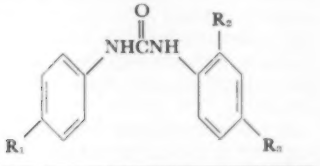
Some of the substituted carbanilides examined for anticoccidial activity are listed in Table 1. The compounds were mixed in the ration in concentrations of 0.01 percent or 0.1 percent and fed to young chicks at varying intervals before or after inoculation with oocysts of *Eimeria tenella*. Standardized procedures (*1*) were used throughout, and the criteria of anticoccidial effectiveness included survival rate, severity of lesions, inhibition of oocyst production, and relative weight gain. Based on all these criteria, the responses were classified as negative (0) to maximal (++++).

Under these conditions, the substituted carbanilide complexes varied from effective to ineffective. None of the complexing agents was active. Although DNC had definite anticoccidial activity when it was used alone, the potency was increased at least tenfold when it was complexed with HDP. No increase in anticoccidial activity was observed, however, on administration of a simple mixture of DNC and HDP. Similar studies with *E. acervulina* and *E. necatrix* in chicks and *E. meleagrimitis* and *E. gallopavonis* in poults have shown that the DNC · HDP complex effectively inhibited these species. Comparatively, the DNC · HDP complex is approximately fivefold more potent than nitrophenide (m,m′-dinitrophenyl-disulfide) in cecal coccidiosis.

Table 1. Anticoccidial response of substituted carbanilides.



R_1	R_2	R_3	Complexing agent	Dosage (% in feed)	Relative anticoccidial response
NO_2	H	NO_2	None	0.1	+
NO_2	H	NO_2	HDP	0.01	++++
NO_2	H	NO_2	AT	0.01	++++
NO_2	H	NO_2	PYR	0.01	+++
NO_2	CH_3	NO_2	HDP	0.1	+
NO_2	CH_3	NO_2*	None	0.1	0
NO_2	H	CN	HDP	0.01	+
NO_2	H	CN*	None	0.1	0
Cl	H	Cl	None	0.1	0
H	H	H	None	0.1	0
Reference standard— Nitrophenide				0.05	++++

* A description of the preparation of this previously unreported carbanilide is in preparation.

This complex has been examined also for antiparasitic activity in other protozoan infections. These have included *Plasmodium gallinaceum* in chicks, *Trichomonas foetus* in mice, and *Histomonas maleagridis* in turkeys. The DNC · HDP addition compound has about one-tenth of the antimalarial potency of quinine, but there was no evidence of antitrichomonas or antihistomonas activity.

Chemical studies have indicated that in addition to HDP and the 2-hydroxypyrimidine, a variety of other polar compounds yield 1-to-1 molecular complexes with DNC. These include 3-amino-*as*-triazine (AT), 2-hydroxypyridine (PYR), 2-mercapto-4,6-dimethylpyrimidine, formamide, dimethylacetamide, dimethylformamide, tetramethylurea, and acetylpiperidine. Certain hydrochlorides, for example, pyridine hydrochloride and trimethylamine hydrochloride, complexed with DNC in an equimolar ratio, whereas the free bases did not react. The numerous DNC complexes showed varying anticoccidial activity. None was more active than the DNC · HDP adduct.

It was of ancillary interest to examine the behavior of structural analogs of DNC (Table 1) toward HDP under uniform complexing conditions. It is interesting that those carbanilides that gave equimolar complexes with HDP contained at least one electron-withdrawing parasubstituent. Others, for example, 4,4′-dichlorocarbanilide and carbanilide, failed to react. The same effect was observed also in the phenylurea series. Although p-nitrophenylurea and p-cyanophenylurea afforded equimolar complexes, p-chlorophenylurea, and phenylurea did not under the same reaction conditions.

The preparation of the DNC · HDP complex illustrates the general method used in this work (*2*). At room temperature the sparingly soluble DNC extracted exactly one molar equivalent of HDP within 30 min from a stirred methanolic solution. On filtration, a nearly quantitative yield of the equimolar DNC · HDP complex, mp 265° to 275° dec., was obtained. (Analysis calculated for $C_{19}H_{18}N_6O_6$: C, 53.51; H, 4.25; N, 19.71; found C, 53.63; H, 4.30; N, 19.75.) Ultraviolet light absorption in concentrated sulfuric acid: λ_{max}^{mu} 298, $A\,{}^{\%}_{1\,cm}$670. The infrared spectrum (Nujol mull) was characterized by disappearance of the N—H stretching frequency (3.03 μ) present in the DNC spectrum, retention of the 5.75 μ C=O band, and shifting or splitting of several maxima in the 6 to 16 μ region. The x-ray powder diagram of the DNC · HDP complex is different from that of either component. Other complexes were similarly identified.

Although it has not been definitely established, hydrogen bonding between the complexing agent and the urea portion of the substituted carbanilide appears likely. In this connection it is noteworthy that Birtwell (*3*) recently postulated a resonance stabilized, eight-membered, hydrogen-bonded, cyclic structure for the urea · HDP equimolar complex. We have assigned the generic name, nicarbazin, to the DNC · HDP complex.

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3 May 1955

Chronic Uncontrolled Cross-Circulation in Unanesthetized Dogs

A technique for performing cross-circulation in anesthetized dogs was described in a previous report from this laboratory (*1*). In that study, the animals were cross-circulated for periods up to 24 hr by means of polyethylene tubing connections between the carotid artery of each animal and external jugular vein of the other. Regulation of blood flow between the partners was not necessary. The present report (*2*) describes a method for cross-circulation in unanesthetized dogs. Eight pairs of dogs were cross-circulated for periods from 47 to 100 hr in the nonanesthetized state.

Under sodium pentobarbital anesthesia, an external jugular vein and carotid artery of two dogs are cannulated with polyethylene tubing (No. 350, Clay-Adams, animal-tested). The necks of the

animals are placed together, and the arterial cannulas of each animal are connected to the other's jugular vein cannula with a short connecting piece of polyethylene tubing (No. 360, Clay-Adams). The necks of the two dogs are then snugly approximated with a plaster cast, leaving the central portions of the cannulas and the connecting pieces exposed. The animals are heparinized prior to and throughout the cross-circulation period, at a dosage of 2 mg/kg every 6 hr.

Recovery from anesthesia is uneventful, and the animals eat and drink well in the postoperative period. Ambulation is difficult in the first postoperative day but is much improved thereafter. A rigid anticoagulant schedule must be maintained if thrombosis is to be avoided. Blood flow may be determined by turning the dogs on their backs and inserting a flowmeter between the artery and vein tubings. Blood flow in our series, as measured with a rotameter, ranged from 200 to 700 ml/min.

Figure 1 shows a pair of dogs that had been in cross-circulation for 72 hr at a flow of 400 cc/min. In Fig. 2 may be seen the plastered necks and connecting tubings. Rectal temperatures do not differ more than 1 deg C in these cross-circulating animals, and blood flows remain relatively constant for days. They may be separated at any time by clamping the connecting tubings and removing the plaster. All eight pairs in this series were electively disconnected and used for studies in homotransplantation immunity. Two pairs were cross-circulated again at a later date, without untoward event.

The procedure of chronic uncontrolled cross-circulation results in rapid and continuous intermingling of the blood streams of the partners. With proper attention to details of cannulation, plastering, and heparinization, the technique is safe for at least 100 hr. There is no reason to believe that longer periods of cross-circulation would be unattainable.

Fig. 1. Pair of dogs in cross-circulation.

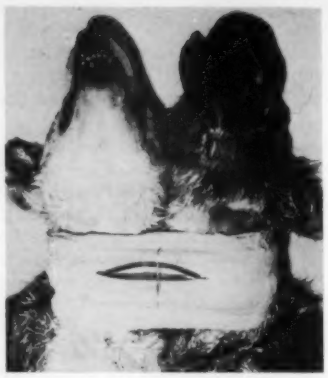

Fig. 2. Necks of cross-circulating dogs. Note nail connecting plaster struts to protect connecting tubings.

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1. R. H. Egdahl, *Federation Proc.* **14**, 42, 1955.
2. The opinions and assertions contained in this communication are my private ones and are not to be construed as official or as reflecting the views of the Navy Department or of the naval service at large.

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26 May 1955.

Systematization of Journal Practices

All authors who write for more than one journal must welcome the discussions in these pages [*Science* **121**, 7A (21 Jan. 1955); **121**, 444 (25 Mar. 1955); and so forth] of the advantages of uniform editorial requirements. I should like to add some definite proposals, some of which, I hope, will prove to be generally acceptable.

Although I should like to see a single system for references, I believe that there is too much rugged individualism among editors to hope for this sort of millenium. A more practical goal, it seems to me, would be the adoption of about three standard long forms, such that all the forms of all of the cooperating journals could be obtained by striking out appropriate portions of one of the long forms. This would minimize the difficulties of preparation while requiring only incomplete agreement among editors.

Behind any agreement on style of references, there should be a keen realization that the references are there for the reader, not for the writer and especially not for the editor. To me this necessitates flexibility and the giving of necessary details—flexibility enough, for example, to allow citation of author and date in the text whenever readers are likely to be able to recognize the exact reference from this information. Necessary details will usually include, except possibly in review articles, at least an indication (in the list of references) of the title of each article.

Once upon a time, references to papers were crude and hard to use, at least by present standards. Giving author, journal, and year was thought to be enough. It was not felt necessary either to mention page numbers, or to single out one of the possibly many papers by that author in that volume. Today we do better, except with references to books! Citing a 900-page book without any further detail is apparently quite proper; yet the reader may have more difficulty in finding what is meant than he would have with a "volume only" reference to a journal. If references are to be oriented to the reader's use, then references to books should at least refer to chapters and often to sections.

In passing, it is my observation that more persons read the footnotes than read the text. Whether this is caused by the focusing of attention on rare events, the natural perversity of readers, or the hope of finding a reference to one's own work, I do not know. But if this observation is correct, only the most important statements should go in footnotes. Since this seems unlikely to come to pass, let us eliminate footnotes entirely or, perhaps, put them all together at the end of the article.

As a separate matter of specific technique, let us look at the technique of our legal colleagues, who deal with more references and cross references than most scientists do. They have for a long time found it convenient to place the volume number *before* the periodical's name or abbreviation. Why do we not do the same? Editors may find it strange, but 121 *Science* 444 flows smoothly from my tongue and makes a great saving in punctuation marks and space.

Is it not time for an editor to be heard from now?

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20 May 1955

Book Reviews

Fluorine Chemistry. vol. II. J. H. Simons, Ed. Academic Press, New York, 1954. x + 565 pp. Illus. $13.50.

Volume II of *Fluorine Chemistry*, like volume I, is composed of contributed chapters. Some of these are excellent. Perhaps the most outstanding chapter in this book is the one contributed by Philip J. Elving, "Anlaytical chemistry of fluorine and fluorine-containing compounds." This chapter is new to this two-volume series, and it covers the analytic aspects of fluorine chemistry very well. The most modern methods for the determination of the fluoride ion, the detection and identification of fluorine, and the determination of fluorine in fluorine compounds are presented in an elegant manner. Also, an extensive bibliography is given as a part of this chapter and should be of value to those interested in the analytic aspects of fluorine chemistry.

H. J. Emeléus is the author of two of the chapters, one of which is on "Halogen fluorides," giving recent advances with these substances. This chapter is interesting but short, since a more extensive discussion of the subject occurs in volume I. The other chapter by Emeléus is an excellent one on "Metallic compounds containing fluorocarbon radicals and organometallic compounds containing fluorine." There has been a great deal of excellent work on these substances in recent years. A number of compounds, such as trifluoromethyl derivatives of mercury, phosphorus, arsenic, sulfur, magnesium, and zinc, have been prepared, and some of their properties have been determined. A number of alkyl and aryl silicon fluorides are reported. It is interesting to note that the chapter is devoid of perfluoro alkyl silanes.

A chapter by Alan G. Sharpe on complex fluorides of groups 1–8, inclusive, shows that there is a great deal now known on fluorine-containing complex salts and acids. Methods of preparation and chemical properties are discussed.

The chapter by Paul Tarrant on "Organic compounds containing fluorine" is an interesting review of selected researches with fluorine-containing organic substances. Derivatives of hydrocarbons, alcohols, ethers, aldehydes, acids, amines, dyes, drugs, pesticides, and polymers are taken up as separate sections. It would not be practical to cover completely this subject matter in one chapter, but Tarrant has given some of the most interesting and significant achievements on the preparation and properties of these substances. In addition, he has given a table on the properties of organic fluorine compounds. This table includes a method of preparation and a literature reference for each of the compounds listed. The bibliography, which covers 556 references, should be of value to those doing research in this field of fluorine chemistry. Unfortunately, at least two types of nomenclature are used in this chapter, one of which has no basis for acceptance.

The chapter on "Fluorocarbon chemistry" by the editor presents some valuable information on the preparation and properties, especially physical properties, of fluorine-containing organic substances, including fluorocarbons. Most of the compounds in this chapter are given by structure or molecular formula. When compounds are named, it is frequently by a system of nomenclature used seldom except by the author himself.

Infrared spectra are given for a large number of fluorine-containing organic substances. This chapter by D. G. Weiblen discusses, among other things, stretching frequency for several groups of atoms, such as C=C, C=O, C≡N.

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An Introduction to Plant Taxonomy. George H. M. Lawrence. Macmillan, New York, 1955. viii + 179 pp. Illus. $3.25.

This is largely a distillation, designed "for the adult amateur botanist and the student of a local flora course at the college level," of the same author's excellent *Taxonomy of Vascular Plants* (1951). The core of the *Introduction* consists of a beautfiully illustrated compendium of external plant morphology that should prove most welcome to the student. One might quarrel with the retention of the pre-evolutionary and outmoded term *pistil*, and of an artificial classification of fruits, but the chapter is doubtless designed to match the terminology in current manuals. Only slightly less central is the chapter on important plant families, in which 42 groups are represented by thumbnail descriptions and, frequently, by line drawings.

Supplementary chapters include a terse history of the development of plant classification and a history of plant taxonomy in the United States based largely on the books of Rodgers, respectively. The former stresses the phylogenetic systems of Engler (with an uncredited diagram that I recognize as that prepared several years ago by Thomas Morley), Bessey, and Hutchinson. The "modern" aspects of taxonomy are treated very sketchily and serve principally to inform the student that such matters may deserve consideration. The author's abridged remark that "phylogeny . . . is not essential to the demands on taxonomy as a functional science," does not seem calculated to stimulate such interest.

Lawrence's books should be given full credit for elevating textbooks in this field to the level of teaching. The *Introduction* will command a wide audience, and its limited scope and lower cost should encourage its adoption as a textbook.

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The Gyroscope Applied. K. I. T. Richardson. Philosophical Library, New York, 1954. 384 pp. Illus. $15.

The author states in the introduction that the purpose of this book is to describe what the gyroscope is, how and why it works and to indicate how and why it has come to play such an important part in scientific progress, especially in marine and aeronautical transportation and military operations. The book is divided into five sections, the first being a general statement of the basic principles and describing some of the wider known applications of gyroscopic properties. This is followed by individual sections devoted, respectively, to marine navigation and stabilization, aeronautical navigation and automatic control, military weapon control and sighting, and finally the use of gyroscopes on land for such devices as monorail and two-wheeled vehicles and for surveying. As would be expected, most of the contents deal with British-manufactured equipment.

The section on marine applications describes the Sperry, Brown, Anschütz, and Plath gyro compasses, the application of the gyro compass to automatic steering control, and the gyroscopic stabilization of ships. All instruments and apparatus are carefully and clearly described and are illustrated by excellent diagrams and by many halftone reproductions of photographs. (The book is

printed on glossy paper, and the quality of the illustrations is to be commended.)

The section on aeronautical applications includes a description of navigational instruments, gyro-verticals, rate-of-turn indicators, and automatic pilots. Naval gunnery, aircraft bombsights, gyroscopic gunsights, and the control of torpedoes and guided missiles are discussed in the section on military applications. This section is understandably brief, although the automatic pilot mechanism of the V-2 is described in some detail. References are given throughout the book and a bibliography is included in the appendix.

The book is recommended as a reference to anyone wishing to learn the details of the practical applications of gyroscopic principles. It is in no sense a textbook and the description of "why" the gyroscope works is not as complete or satisfactory as that of "how."

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Fundamentals of Radiobiology. Z. M. Bacq and Peter Alexander. Academic Press, New York; Butterworths, London, 1955. xii + 389 pp. Illus. $6.50.

This book is a stimulating review of radiation biology as it appears to a physiologist and a radiation chemist. The first four chapters deal with the elements of radiation physics and with the radiation chemistry of water and of large molecules. They are a succinct and well-balanced review of the basic principles and recent developments in these fields. The emphasis in much of the remainder of the book is on the early biochemical and physiological effects, especially in mammals. Considerable space is devoted to protective substances and means of influencing recovery. The view is developed that many of the biological effects are mediated by radicals, especially HO_2, and that the original damage is often in the cytoplasmic organization, quite possibly in the structures that serve to keep the various enzyme systems and substrates partially separate from one another. This book is the most complete presentation of this point of view available and obviously contrasts sharply with interpretations that emphasize the role of the nucleus and the target theory. One may disagree with some of the conclusions but must still recognize that it is a thought-provoking account well worth careful reading.

However, there are certain shortcomings that cannot be entirely ignored. The proofreading was not done very carefully. More data should have been given on the toxicity of compounds, such as cysteamine, that are recommended as practical protective agents. One could wish that more effort had been made to relate the biochemical and physiological findings with histological and cytological observations. For example, it would be useful to know how far some of the biochemical effects could be interpreted as incidental consequences of cell death.

The chapter on cytology and genetics is to a very large extent confined to the Koller-Darlington point of view. This is not the place to detail the objections that can be raised to their position. The real difficulty arises from the misleading one-sidedness of the chaper. A reader unfamiliar with the field would hardly realize that there was another point of view with a considerable group of adherents. Thus a paragraph is devoted to Lane's intensity experiment without mention that three groups of workers have failed to confirm his work and have severely criticized portions of it. It would have been better to have omitted this chapter entirely than to have given such a misleading account.

Despite such shortcomings, the book is an important addition to the literature of radiation biology and should be read by all who are interested in this field.

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The Nucleic Acids. Chemistry and biology. vol. I. Erwin Chargaff and J. N. Davidson, Eds. Academic Press, New York, 1955. xi + 692 pp. Illus. $16.80.

To surpass an excellent little compendium entitled *The Biochemistry of the Nucleic Acids*, its author would have to enlist a constellation of experts and somehow contrive to distill from the separate work of their several minds an organized treatment of this ever-growing topic. With the aid of an equally illustrious fellow-editor, that British author has succeeded in accomplishing these things in volume I of what promises to be the classic reference book in the nucleic acid field.

In the first volume the organic and physical chemistry of the nucleic acids and their constituents and the distribution in nature of the component purine and pyrimidine bases are thoroughly considered. A later volume is to deal with the biological distribution and functions of the nucleic acids, their biosynthesis and that of their constituents. Except for the compact little book mentioned, there has been no treatise issued in this field for almost 25 years. It might be best to indicate for prospective readers the scope and character of this rather expensive new book rather than attempt high criticism of what is, after all, the only work of its kind.

A short introduction by the editors builds a historical framework that helps to provide perspective and organization for the contributed chapters that follow. W. G. Overend and M. Stacey now begin to weave the story of the nucleic acids by telling the history and distribution of the sugar components. There follows a guide to the preparation and properties of ribose, deoxyribose, and related compounds, complete with a table giving the optical rotation and melting point of more than 200 derivatives. The purines and pyrimidines are dealt with in a chapter by A. Bendich that includes a good survey of their physical and chemical properties. The classic synthetic work of the 1890–1930 period is made accessible and integrated with modern work in a manner applicable to future problems of synthesis of purine or pyrimidine intermediates, analogs, and coenzymes, for example, those bearing isotopic constituents.

In Chapter 4 the more complex chemistry of the nucleosides and nucleotides limits J. Baddiley more sharply to the past and present. The difficult work that has been done in this area is competently described, and some attempt is made to discuss the principles, possibilities, and limitations of making conversions in these more complicated molecules. Isolation from nature (thrice capitalized: *Nature*) has a somewhat awesome aspect in this chapter; thymine deoxyribose-3-phosphate is called "unnatural" since it has not been isolated, although it is certainly contained in deoxyribonucleic acids (DNA). The biochemistry of the nucleotide coenzymes is well represented, although only briefly; it does not appear that this subject will be taken up elsewhere in the two volumes.

There follow several chapters dealing with methodology in analysis and separation of nucleic acids. In a short one, H. S. Loring describes experiences with the hydrolysis of nucleic acids and some of his own methods for base analyses of ribonucleic acids (PNA) by precipitation and spectrophotometry. Data are given for yeast, tobacco mosaic virus, mitochondrial and microsome, PNA composition. The ion-exchange chromatography of the bases, nucleosides, mono- and poly-nucleotides is discussed with brilliant clarity in a veritable manual of methods by W. E. Cohn. The principles and alternative approaches included should certainly make this useful for those encountering new separation problems. A treatment of paper chromatography of bases and nucleosides by G. R. Wyatt follows; methods of hydrolysis are critically examined, and there is much information about choice of solvent and quantitative technique. This author should receive special praise for his effi-

cient inclusion of an enormous number of helpful clues to simplification and variation, useful facts, and warnings about pitfalls, in a remarkably readable account. A brief discussion by J. D. Smith makes the reader acquainted with the up-to-date electrophoretic separations so useful especially for nucleotides. By way of comparative methodology, a chapter by Dische gives a glimpse into a glass-windowed analytic laboratory wherein one can judge the range, sensitivity, and sources of error of a series of alternative colorimetric methods for determining the sugars, bases, and phosphorus of nucleic acids and nucleoproteins.

A long chapter by Chargaff and another by his colleague F. Magasanik deal with the isolation, purification, characterization, preservation, and denaturation, and with the regularities in composition, of the DNA's and PNA's, respectively. The thorough discussions include most of the reliable available data on analyses of animal, plant, bacterial, and virus nucleic acids. Here at long last is an editor who believes in the retention of individuality, for almost every "long view" in his chapter is flavored with figurative expression or whimsy. To borrow his manner, one might say that every glance upward from his microscope is marked with a genial chuckle or a sly grin.

Evidence is impressive in the section by D. M. Brown and A. R. Todd that the contribution of the organic chemist to biochemistry can be (both figuratively and literally) synthetic as well as analytic. Carrying on where Baddiley left off, these authorities cover the important direct chemical approaches that have refined our knowledge of the intranucleotide linkages. D. O. Jordan gives a clear, well-illustrated picture of the physical properties, shape, size, and organization of nucleic acids, in both the dry and the dissolved state. The important dissociation, optical diffraction, scattering, and flow parameters are considered in themselves and as they are affected by *p*H or ionic strength. Light absorption and dichroism are covered by G. H. Beaven, E. R. Holiday, and E. A. Johnson with inclusion of tables and curves bearing much standard and basic data. Finally, in a comprehensive review of all the depolymerases, hydrolases, phosphatases, deaminases, and oxidases affecting nucleic acids and their components, G. Schmidt provides an impressive reference work.

From one-third to well over one-half of the cited literature references are dated 1950 or later, and another one-fourth are from the preceding 5 years, in the various chapters; there are a total of 300 or more in several cases. Copious cross references have been provided; as in so many books a large part of these are to whole chapter numbers, an inconvenience since only 15 out of more than 600 pages show the number of the chapter at which one is looking.

The completed work cannot fail to be a major source book and basic reference. It seems to have a coherence and integration that are unexpected for a complex of so many sections and retains most of the advantages derived from purifying a large body of literature through the minds of active contributors.

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Radioisotope Conference, 1954. vol. I, *Medical and Physiological Applications.* Proc. Second Conference, Oxford, 19–23 July. J. E. Johnston, Ed. Academic Press, New York; Butterworths, London, 1954. xi + 418 pp. Illus. $10.80; vols. I and II, $16.

The Second Radioisotope Conference was held in Oxford in July 1954. Forty-six papers record current research in which radioisotopes have been utilized for varied problems in the medical, biochemical, and agricultural sciences. The conference was international in participation, and an examination of this volume illustrates the numerous applications of radioisotopes to medical and biochemical problems.

Half of the papers are of interest primarily to those concerned with therapeutic and diagnostic applications of radioisotopes. Six papers illustrate applications of radioisotopes to problems in plant nutrition and plant physiology. The remainder of the papers illustrate the applications of radioisotopes, principally C^{14}, I^{131}, and tritium, to biochemical problems. The research presented in most cases was current, and in some instances the results were only preliminary. Prompt publication of the volume has been achieved, which enhances the value of the papers. In addition, the discussions occasioned by the presentation of each paper have been included and are of considerable interest.

It is my opinion that only a few papers in this volume will be of direct interest to any one person, owing to the wide range and specialized nature of the applications of radioisotopes that have been covered. However, the majority of the articles are readily understandable to the nonspecialist, and as a result, a perusal of this volume may provide one with useful ideas for the application of radioisotopes to new problems in varied fields.

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The Plant Quarantine Problem. W. A. McCubbin. vol. IX of *Annales Cryptogamici et Phytopathologici.* Frans Verdoorn, Ed. Ejnar Munksgaard, Copenhagen (U.S. distr.: Chronica Botanica, Waltham, Mass.) 255 pp. $4.80.

W. A. McCubbin has done an outstanding job of presenting and reviewing the various aspects of plant quarantines, including their biological background, social and economic relationships, legal features, and administration. There is also an over-all appraisal of the plant-quarantine problem and a discussion of quarantines from the international standpoint. A concise historical summary of federal quarantines that have been promulgated on account of plant diseases is given in an appendix.

The subject matter is well organized, clearly presented, and easy to read. The book is arranged and indexed to facilitate ready reference. It is a valuable addition to the reference literature on this subject, particularly since it represents the first time that the entire field of plant quarantines has been covered in one volume.

The author is exceptionally well qualified to discuss all phases of the plant-quarantine problem, having had more than 30 years experience in the enforcement of state quarantines as well as federal foreign and domestic quarantines. During this period he was engaged in both administration and actual enforcement in the field. This background has enabled him to present his subject so that the book not only should be useful as a reference to plant regulatory workers, teachers, scientists, and similar groups but also should be of interest to the layman who is affected by plant quarantines.

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Glass Reinforced Plastics. Phillip Morgan, Ed. Iliffe, London; Philosophical Library, New York, 1954. vii + 248 pp. Illus. $10.

This volume contains 15 chapters, each written by a separate contributor, arranged to cover the various phases involved in the manufacture and use of glass-reinforced plastics. These products constitute a relatively new class of materials, which are finding increasing applications in industry. The coverage includes glass-fiber forms and properties, chemistry of the usable resins, commercial fabrication of the desired shapes, and industrial applications.

Glass fibers offer several advantages

over other materials when they are used as reinforcement in plastic structures and are available to the industry in both the short length or staple form and in continuous lengths. Many glass cloths and weave types are available, and further variety is afforded by choice of the type of glass from which the fibers are made.

Discussion of the chemistry of resins covers the polyesters, phenolics, epoxides, silicones, melamines, and furanes. Ancillary materials, such as catalysts, fillers, accelerators, release agents, and pigments are discussed in relation to their use with different resins. The choice of glass-fiber type and resin type depends upon particular requirements, such as electric resistance, dielectric loss, or chemical resistance. The fabricator has a number of commercial production molding processes at his disposal for forming the desired shapes, including laminates, complicated shapes, tubes, and rods.

Properties of glass-reinforced plastic structures depend upon the separate properties of the glass fibers and resins used, the way in which they are combined in the shape, and the design of the article. These features have made such materials very useful in the aircraft industry, automobile and boat-building body work, and other transport applications, laminates in the electrical field, and miscellaneous applications.

This book gives a good introduction to those interested in applications of these materials. References given are sufficient for more detailed study of the subjects covered.

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Peripheral Nerve Injuries. Medical Research Council Special Rept. Ser. No. 282. H. J. Seddon, Ed. Her Majesty's Stationery Office, London, 1954. xvi + 451 pp. Illus. £2 15s.

The plans for this report were laid during World War II at the time of the appointment of a Nerve Injuries Committee headed by George Riddock, who had been secretary of a similar committee during World War I. At his untimely death, the chairmanship of this committee was taken over by H. J. Seddon. The plan in which this report was to be carried out, with regard to both the investigative work and the manner in which cases were to be followed, was a tribute to the committee. It is emphasized that the work reviewed in this report is collected from only a few selected centers headed by members of the committee. The reliability of the work performed under each member of this committee is unquestioned. The report is not an attempt to present a complete analysis of the diagnosis and treatment of injuries of the peripheral nerves but rather is a presentation of the advances made in the understanding of nerve injuries by British workers during the war years.

The report, some 428 pages, is essentially a collection of papers by the various authors. Some of these are fairly didactic in their approach, reviewing the literature in detail and presenting definite conclusions; whereas others present a definite attempt to analyze the results of treatment in certain types of cases. Special mention should be given to the initial portion of the book by Seddon, in which he emphasizes again the way in which the results were collected. His own analysis of the frequency of anomalous nerve innervation, particularly to the muscles of the human hand, is an especially important one. There are important sections on various types of nerve injuries and on the histopathology of nerve injury, causalgia, and detail presentations of electric diagnosis of peripheral nerve injury and electromyography. This factual presentation does not leave out the importance of the human factor as related to morale. This is particularly evident in the section entitled "Factors influencing functional recovery" by Ruth Bowden. A brief quotation from this section serves to emphasize this.

"Splints, active and passive exercises and physiotherapy play an important part in re-education by preventing or minimizing the adverse effects of degeneration and by maintaining mobility of the part; but one of the most significant factors appears to be the necessity for constant usage at work, in pastimes and sport.

"Surgical intervention for repair of damaged nerves or reconstruction is but an incident in the treatment, for the ultimate success of all therapeutic measures lies, to a large extent, in the hands of the patient. Once this factor is appreciated, the willing cooperation of most of them was remarkable."

A particularly useful section of this book is by Robert Zachary, who gives a statistical, as well as a detailed, analysis of the results of nerve suture. Other detailed sections on nerve grafting and brachial plexus injuries are included and are of considerable value, both in the technical details and in the statistical analyses. Of great importance is the factor brought out in the British survey that recovery in all peripheral nerves usually continues for approximately 3 years after repair and that in some cases this recovery may continue up to 5 years. The long term follow-up in a large number of the cases is therefore important.

This book is singularly free of errors and, in view of the fact that portions of it are presented by various well-known authors, it is singularly free of controversy or contradictions. It is printed on high-quality paper and is written in the usual excellent English style.

The eventual publication of this massive analysis of the teamwork of numerous British workers is a piece of work that will be of value to all neurologists and neurosurgeons and to all those interested in neuroanatomy and neurophysiology. It will be of particular value to anyone writing on any facet of peripheral nerve injury, for in this volume is contained useful information on almost all aspects of this subject.

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New Books

High Energy Nuclear Physics. Proceedings of the fifth annual Rochester conference, 31 Jan.–2 Feb. 1955. Compiled and edited by H. P. Noyes, E. M. Hafner, G. Yekutieli, and B. J. Raz. Univ. of Rochester, Rochester, Interscience, New York, 1955. 198 pp. $2.50.

Physiologie der Zelle. Johannes Haas. Borntraeger, Berlin, 1955. 474 pp. DM. 48.

Treatise on Invertebrate Paleontology. part E, *Archaeocyatha and Porifera.* Prepared under the guidance of the Joint Committee on Invertebrate Paleontology. Raymond C. Moore, Ed. Univ. of Kansas Press, Lawrence; Geological Soc. of America, New York 27, 1955. 122 pp. $3.

Security for All and Free Enterprise. A summary of the social philosophy of Josef Popper-Lynkeus. Henry I. Wachtel, Ed. Philosophical Library, New York, 1955. 162 pp. $3.

Problems of Consciousness. Transactions of the fifth conference. Harold A. Abramson, Ed. Josiah Macy, Jr. Foundation, New York, 1955. 180 pp. $3.50.

The Natural History of Tsetse Flies. An account of the biology of the genus *Glossina* (Diptera). Memoir No. 10, London School of Hygiene and Tropical Medicine. Lewis, London, 1955. 816 pp. £4 4s.

Basic Processes of Gaseous Electronics. Leonard B. Loeb. Univ. of California Press, Berkeley, 1955. 1012 pp. $13.50.

A Laboratory Manual of General Chemistry. Saverio Zuffanti, Arthur A. Vernon, and W. F. Luder. Saunders, Philadelphia–London, 1955. 308 pp. $3.75.

Adaptive Human Fertility. Paul S. Henshaw. Blakiston Div., McGraw-Hill, New York–London, 1955. 322 pp. $5.50.

Salamanders and Other Wonders. Still more adventures of a romantic naturalist. Willy Ley. Viking, New York, 1955. 293 pp. $3.95.

Standing Room Only. The Challenge of overpopulation. Karl Sax. Beacon Press, Boston, 1955. 206 pp. $3.

New Methods in Analytical Chemistry. Ronald Belcher and Cecil L. Wilson. Reinhold, New York; Chapman & Hall, London, 1955. 287 pp. $5.50.

Cancer through the Ages: the Evolution of Hope. Francelia Butler. Virginia Press, Fairfax, 1955. 147 pp. Paper, $1.

The Story of Medicine. Kenneth Walker. Oxford Univ. Press, New York, 1955. 343 pp. $6.

Vascular Plants of Illinois. George Neville Jones and George Damon Fuller, *et al.* Univ. of Illinois Press, Urbana, 1955. 593 pp. $10.

Blood Supply and Anatomy of the Upper Abdominal Organs. With a descriptive atlas. Nicholas A. Michels. Lippincott, Philadelphia, 1955. 581 pp. $24.

Some Beautiful Indian Trees. Ethelbert Blatter and Walter Samuel Millard. The Bombay Natural History Soc., Bombay, India, ed. 3, 1955. 165 pp. 30s.

Practical Physics. Marsh W. White, Kenneth V. Manning, Robert L. Weber. McGraw-Hill, New York–London, ed. 2, 1955. 484 pp. $5.50.

College Chemistry. An introductory textbook of general chemistry. Linus Pauling. Freeman, San Francisco, ed. 2, 1955. 685 pp. $6.

Histologische Geschwulstdiagnostik. Systematische morphologie der menschlichen geschwulste als grundlage für die klinische beurteilung. A. V. Albertini. Thieme, Stuttgart, 1955. 544 pp. $23.40.

Report Writing. John Ball and Cecil B. Williams. Ronald, New York, 1955. 407 pp. $4.75.

The Physiology of Domestic Animals. H. H. Dukes. Comstock Div., Cornell Univ. Press, Ithaca, N.Y., ed. 7, 1955. 1020 pp. $9.75.

Experimental Design and Its Statistical Basis. D. J. Finney. Univ. of Chicago Press, Chicago, 1955. 169 pp. $4.50.

Introduction to Parasitology. With special reference to the parasites of man. Asa C. Chandler. Wiley, New York; Chapman & Hall, London, ed. 9, 1955. 799 pp. $8.50.

Mesons and Fields. vol. II, *Mesons.* Hans A. Bethe and Frederic de Hoffmann. Row, Peterson, Evanston, Ill., 1955. 446 pp. $8.

Corn and Corn Improvement. Agronomy Monogr. vol. 5. George F. Sprague, Ed. Academic Press, New York, 1955. 699 pp. $11.50.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

FAO Fisheries Bulletin. vol. VII, No. 2. Contribution of oceanographic research to fisheries science. Food and Agr. Organization of the UN, Rome, 1955. 48 pp.

Year Book of the International Council of Scientific Unions 1955. The Council, London, 1955. 69 pp. 5s.

Morphometric Comparison of Yellowfin Tuna from Southeast Polynesia, Central America, and Hawaii. Milner B. Schaefer. Bull. vol. 1, No. 4. Inter-American Tropical Tuna Commission, La Jolla, Calif., 1955. 136 pp.

Red Foxes and a Declining Prey Population. Monogr. Ser. No. 1. Thomas G. Scott and Willard D. Klimstra. Southern Illinois Univ., Carbondale, 1955. 123 pp.

The Exterior Bird. Leon Kelso. The author, Aurora, Colo. 51 pp.

The Rural Hospital: Its Structure and Organization. Monogr. Ser. No. 21. R. F. Bridgman. World Health Organization, Geneva, 1955. 162 pp. $4.

1954 Oil and Gas Developments in Ohio. Petroleum and Natural Gas. Ser. No. 7. Robert L. Alkire and Bernard A. Floto. Dept. of Natural Resources, Div. of Geological Survey, Columbus, Ohio, 1955. 58 pp.

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Scientific Meetings

Peaceful Uses of Atomic Energy

The International Conference on the Peaceful Uses of Atomic Energy, an outgrowth of President Eisenhower's proposal to the United Nations on 8 Dec. 1953 for a pooling of atomic knowledge for peacetime use, will convene at the Palais des Nations in Geneva, Switzerland, on 8 Aug. The conference was called in accordance with a United Nations resolution, which was adopted unanimously by the General Assembly on 4 Dec. 1954, that stated ". . . an international technical conference of Governments should be held, under the auspices of the United Nations, to explore means of developing the peaceful uses of atomic energy through international cooperation and, in particular, to study the development of atomic power and to consider other technical areas—such as biology, medicine, radiation protection, and fundamental science—in which international cooperation might most effectively be accomplished." The decision to hold the conference formed part of a resolution that was originally sponsored by the governments of Australia, Belgium, Canada, France, the Union of South Africa, the United Kingdom, and the United States. The first part of the resolution expressed the hope ". . . that the International Atomic Energy Agency will be established without delay."

All 60 member states of the United Nations, as well as 24 other states that are members of the specialized agencies, were invited to participate. In addition, the 10 specialized agencies themselves were invited. Sixty-six governments have accepted, of which 33 submitted papers. Each participating state and agency has been allotted five delegates, who may be accompanied by as many advisers as they may need.

The conference is to be scientific and nonpolitical in character; it will not pass resolutions or make recommendations. It is intended to provide a meeting place where scientists and other experts from all parts of the world may exchange information, most of it more of an applied nature rather than of a theoretical nature. Approximately 440 papers of the some 1100 that were submitted to the U.N. will be presented. Papers for the conference were screened twice: each government's participating agency selected papers written by its own nationals for submission to the U.N.; a U.N. committee then made a final selection. All accepted papers, whether or not they are presented orally, will be printed in the conference proceedings.

An exhibition will be held in conjunction with the conference. The exhibits of all countries will be divided into two categories, a scientific or technical exhibit designed primarily for the delegates, and a popular or commercial exhibit designed for the general public. The technical exhibits will be shown in the Palais des Nations; the commercial exhibits, in the Palais des Exhibitions in downtown Geneva. The commercial exhibit was organized by a private firm in Geneva, the Organizing Committee for The First International Exhibition of the Peaceful Uses of Atomic Energy.

Sixty 3-hr sessions have been scheduled. Most of the speaking time has been allotted to the United States (52 hr), the United Kingdom and the Soviet Union (approximately 19 hr each), Canada, and France. All sessions will be open to the public and simultaneous translation of papers into the four official languages, English, French, Russian, and Spanish, will be made.

Plenary sessions are to be held on the first 3 days and on the last day. The opening sessions will be devoted to survey papers concerned with sources of energy, world power requirements, sources of raw materials, power reactors, and uses of radioisotopes in biology, medicine, agriculture, industry, and general science. The closing session will review the highlights of the conference.

After the opening plenary sessions, there will be three parallel technical sessions, meeting morning and afternoon, devoted to the technical aspects of atomic energy—for example, reactors, reactor physics, reactor chemistry and metallurgy, biology and medicine, and applications of radioisotopes. The discussions will cover all aspects of the use of atomic energy, from raw materials through the fabrication and processing of fuel elements to the disposal of waste. United Nations officials, in mapping the conference, have placed considerable emphasis on reports concerned with the economic cost of building nuclear power stations in some of the less industrially developed countries.

Evening lectures of a general character will be given by scientists of world repute on such subjects as accelerators for nuclear particles, elementary particles and mesons, nuclear forces, nuclear structure, the neutron, isotopic dating, uses of radioactive substances in biology and medicine, free radicals, and new elements.

The participating agency for the United States is the Atomic Energy Commission. Delegates are Harry S. Traynor, executive director; George L. Weil, technical director; J. R. McKnight, information officer; Morse Salisbury, deputy information officer; and Laura Fermi, historian. In response to its invitation for the submission of papers, the AEC received slightly more than 1000, of which 524 were submitted to the U.N. after screening and consolidation by 12 review groups; approximately 180 of the 524 are scheduled for oral presentation.

The United States technical exhibit has been designed to supplement the technical papers. It includes an operating swimming-pool research reactor. Educational institutions, research organizations, and more than 50 industrial and commercial firms have contributed pieces of equipment, models, or components for the technical exhibit. Uranium processing, reactor models, reactor components and controls, instrumentation, radioisotopes, and basic research will be shown. Moreover, a 2½- to 3-hr film program will illustrate nuclear reactors for research, construction of a reactor, development of homogenous reactors, sodium-graphite reactors, safety experiments on a boiling-water reactor, and radioisotopes. In addition, the exhibit will include a technical library composed of an AEC depository, a book collection, and a periodical collection.

The U.S. Information Agency's educational exhibit that has been presented in Berlin, Munich, Frankfort, and Vienna will be on display in the Palais des Exhibitions, where the commercial exhibit will also be held. Contributions to the commercial exhibit, which emphasizes instruments and products that are available for sale, came from 22 industrial and commercial organizations.

British scientists will present about 70 papers at the conference. The British displays at the technical exhibition will emphasize research and power reactors. They will include a 19- by 15- by 5½-ft model of the Harwell heavy-water experimental reactor and a detailed model of the Calder Hall atomic power station. Displays at the commercial exhibition will be devoted to a general survey of the peacetime applications of atomic energy in Great Britain. The United Kingdom's delegates are John Cockcroft, Christopher Hinton, J. F. Loutit, George Thomson, and Willis Jackson.

Thirteen papers will be read by members of the Canadian group. Canada's technical exhibit will include reactor models; a collection of radioactive minerals; instruments of many types; two cobalt-60 beam therapy units; and data sheets, blueprints, and diagrams of various reactors and reactor components.

Arrangements for the conference were handled by the Secretary-General of the United Nations, Dag Hammarskjold, and an advisory committee composed of J. Costa Ribeiro (Brazil), W. B. Lewis (Canada), Bertrand Goldschmidt (France), Homi J. Bhabha (India), D. V. Skobeltzin (U.S.S.R.), John Cockcroft (United Kingdom), and I. I. Rabi (U.S.A.). Conference officers are Homi J. Bhabha, chairman of the Atomic Energy Commission of India, president; Walter G. Whitman, chairman of the department of chemical engineering at Massachusetts Institute of Technology, secretary-general; and Viktor S. Vavilov, Institute of Physics of the Academy of Sciences of the U.S.S.R., deputy secretary-general.

Meeting Notes

■ The University of Wisconsin Medical School has announced the program for the Symposium on Metabolic Aspects of Transport across Cell Membranes that is to take place 29–31 Aug. in Madison under the sponsorship of the Wisconsin Alumni Research Foundation and the National Science Foundation. Participants include E. F. Adolph (University of Rochester), D. C. Darrow (University of Kansas), Hans Ussing (University of Copenhagen), M. B. Visscher (University of Minnesota), E. J. Conway (University College, Dublin), Silvio Weidmann (University of Bern), A. M. Shanes (NIH), W. O. Fenn (University of Rochester), W. S. Wilde (Tulane University), R. W. Gerard, (University of Illinois), Frank Brink (Rockefeller Foundation), G. H. Mudge (Columbia University), R. W. Berliner (NIH), R. F. Pitts (Cornell University), R. E. Davies (Oxford University), F. E. Shideman (University of Wisconsin), Karl Beyer (Sharpe and Dohme), A. Farah (University of Syracuse), H. W. Davenport (University of Utah), W. S. Rehm (University of Louisville), Adrian Hogben (NIH), J. R. Elkinton (University of Pennsylvania), David H. P. Streeten (University of Michigan).

■ "Electronics and automatic production" will be the theme of a symposium at San Francisco's Sheraton-Palace Hotel 22–23 Aug., preceding the annual Western Electronic Show and Convention. Jointly sponsored by Stanford Research Institute and the National Industrial Conference Board, Inc., New York, the meeting will include discussions of technical developments, social and economic implications, and the outlook for automation in the national technology.

Luncheon speaker on the opening day will be Charles S. Thomas, Secretary of the Navy, speaking on "Automatic production and national defense." Some 15 papers will be presented.

William D. McGuigan (S.R.I.) is general chairman for the symposium, which is being held "to supplement the numerous strictly technical meetings held recently by giving attention to the basic concepts of automation, its characteristics, and to the broad view of how automation affects business and society."

Among those scheduled to speak are L. M. K. Boelter (University of California, Los Angeles), who will review the growth of automation, and Dean A. Wooldridge (Ramo-Wooldridge Corp.) who will discuss "The outlook for automation." These speakers will attempt to define what is meant by "automation," and to answer the questions: What is it? How did it arise? Where do we stand now? Where is it heading?—and other related questions.

Opportunities and problems in various industries will be dealt with in another session. Case histories of the uses of automatic production in selected industries will be discussed, and techniques and methods that may be transferable from industry to industry will be stressed.

■ The International Union of Theoretical and Applied Mechanics has announced a provisional program for the Colloquium on Deformation and Flow of Solids that is to take place in Madrid, Spain, 26–30 Sept. Participants include Cottrell (Great Britain), "Dislocation in crystals"; P. G. Hodge (U.S.), "Theory of ideal plasticity"; A. Seeger (Germany), "Neuere mathematische Erfolge und Ergebnisse zur Krystallplastizität"; Tessier du Cros (France), "Rôle des dislocations dans les déformations plastiques des métaux polycrystallines"; Charles Crussard (France), "Le mécanisme de rupture des métaux"; Frank (Great Britain), "Genesis of dislocation in crystals grown from the melt"; Bernard Jaoul (France), "Influence des joints intergranulaires sur l'écrouissage des métaux"; E. H. Lee (U.S.), "Wave propagation in anelastic materials"; Leibfried (Germany), "Versetzungen und Gitterstruktur"; J. R. Low (U.S.), "Dislocations" (exact title unknown); N. F. Mott (Great Britain), "Dislocation models for plastic flow and work-hardening"; Velasco de Pando (Spain), "A new theory of plasticity"; Stüssi (Switzerland), "Ergebnisse und Deutung einiger Versuche zur Plastizitätstheorie"; H. Kauderer (Germany); Treloar (Great Britain); F. Schultz-Grunow (Germany), "Das Widerstandsgesetz rheologischer Flüssigkeiten"; M. A. Biot (U.S.), "Variational and La Grangian methods in visco-elasticity"; Henri Le Boiteux (France), "Viscosité et déformation irréversible"; F. K. G. Odqvist (Sweden), "Engineering theories of metallic creep"; M. Reiner (Israel); H. Arveste (U.S.); M. Plesset (U.S.); E. Volterra (U.S.).

■ The section of biophysics and biophysical research of the Mayo Clinic, Rochester, Minn., invites participation in a Symposium on the Biologic Effects of Microwaves that is to take place at the Mayo Foundation House, 23–24 Sept. Since microwave diathermy is a generally accepted method for therapy and since the electromagnetic fields generated by radar equipment are becoming more and more intense, it is important to consider more seriously the physiologic and pathologic effects of microwaves. With this in mind, Fred G. Hirsch (Sandia Corp., Sandia Base, Albuquerque, N.M.) suggested that a symposium on the physiologic and pathologic effects of microwaves be held at the Mayo Clinic, where microwave diathermy was introduced to the medical profession.

The value of such a symposium depends on an assembly of scientists who can contribute collectively to all phases of the field of microwaves. It is hoped that physicists, radar experts, electronic engineers, biophysicists, doctors of medicine, members of the armed forces, and representatives from industrial organizations will attend the conference.

■ An international Conference on Solar Energy—the Scientific Basis will take place at the University of Arizona, Tucson, 31 Oct.–1 Nov. as a prelude to the World Symposium on Applied Solar Energy to be held in Phoenix, Ariz., 2–4 Nov. Both meetings will be jointly sponsored by the Association for Applied Solar Energy, Stanford Research Institute, and the University of Arizona.

Scientists from many countries are expected to attend the Tucson conference to exchange ideas on fundamental principles involved in the application of solar energy. They will then move on to Phoenix to discuss the technologic aspects of the practical utilization of solar energy with world-wide representatives of industry, agriculture, finance, and education.

One of the major objectives of the meeting at the University of Arizona will be to assist investigators in charting the direction of future research. The conference will permit free discussion of the scientific bases on which the utilization of solar energy is founded. Following a

general session, three sections will convene to consider thermal, photochemical, and electric processes for converting the sun's energy to man's use.

Richard N. Thomas (Harvard College Observatory) will open the general session in Tucson with a discussion of the "Features of solar energy as imposed by the physics of the sun"; Sigmund Fritz (U.S. Weather Bureau) will describe the geographic distribution of solar energy, with special reference to systematic programs of observation; and Farrington Daniels (University of Wisconsin) will review the principles and problems of research in the utilization of solar energy.

Three special sessions will be held concurrently on the afternoon of 31 Oct. and the morning of 1 Nov. Everett D. Howe (University of California, Berkeley) will serve as chairman of the section on thermal processes.

Cochairman of the section on photochemical processes will be C. S. French and H. W. Milner (Stanford, Calif., laboratory, Carnegie Institution of Washington). In a discussion of large-scale algae culture, Milner will lead a session on relevant aspects of algal physiology, and French will chairman a session on practical considerations of algae culture.

A session on photochemistry of the higher plants and nonbiological systems is also scheduled; the chairman will be announced later. A third section of the university conference will deal with electric processes, under the chairmanship of G. L. Pearson (Bell Telephone Laboratories, Murray Hill, N.J.).

Foreign participants include Felix Trombe (Laboratoire de l'Energie Solaire, Paris); R. N. Morse (Commonwealth Scientific and Industrial Research Organization, Australia); Hiroshi Tamiya (Tokugawa Institute for Biological Research, Tokyo); Harold Heywood (University of London); and Austin Whillier (South African Council for Scientific and Industrial Research).

The university meeting will conclude with luncheon on 1 Nov. Conference members will go to Phoenix by chartered bus that afternoon for the 3-day program of the world symposium.

Society Elections

■ American Association of Scientific Workers: pres. and representative to the AAAS council, Harry Grundfest, Columbia University; sec., Robert J. Rutman, University of Pennsylvania; treas., Leland Taylor, University of West Virginia. The vice presidents are Hans Blumenfeld, Toronto, Canada; Kirtley Mather, Harvard University; Melba Phillips, New York; Theodor Rosebury, Washington University (St. Louis); and Bernard Schaar, Chicago, Ill.

■ Society for Industrial Microbiology: pres., H. B. Woodruff, Merck and Co., Inc., Rahway, N.J.; v. pres., Glenn A. Greathouse, Orlando Research, Inc., Orlando, Fla.; sec.-treas. and representative to the AAAS council, C. L. Porter, Purdue University, Lafayette, Ind.

■ Societate del Spectroscopistas Molecular: pres., Jerome M. Dowling, 2505 Haymond St., River Grove, Ill.; v. pres., Joseph G. Barredo, University of Chicago; sec.-treas., Ann Palm, 5840 S. Cornell Ave., Chicago, Ill.

■ American Society of Mammalogists: pres., William B. Davis, Texas A. & M. College; cor. sec., George C. Rinker, University of Michigan; rec. sec., Randolph L. Peterson, Royal Ontario Museum of Zoology, Toronto; treas., Caroline A. Heppenstall, Carnegie Museum, Pittsburgh, Pa. The vice presidents are Robert T. Orr, California Academy of Sciences, Golden Gate Park, San Francisco, and Stephen D. Durrant, University of Utah.

■ AAAS, Lancaster Branch: chairman, James M. Darlington, Franklin and Marshall College; v. chairman, Robert L. Moore, Raybestos-Manhattan, Inc., Manheim, Pa.; sec., John L. Byerly, Lancaster Country Day School; treas., Michael A. Lewis, Franklin and Marshall College.

Forthcoming Events

September

5–9. American Inst. of Biological Sciences, Michigan State Univ., East Lansing, Mich. (H. T. Cox, AIBS, 2000 P St., NW, Washington 6.)

The following 24 societies will hold their meetings along with the AIBS during the same week at East Lansing, Mich.

American Bryological Soc. (L. J. Gier, Dept. of Biology, Wm. Jewell College, Liberty, Mo.)

American Fern Soc. (M. E. Faust, 501 University Pl., Syracuse 10, N.Y.)

American Microscopical Soc. (C. J. D. Brown, Dept. of Zoology and Entomology, Montana State College, Bozeman.)

American Soc. for Horticultural Science. (F. S. Howlett, Ohio Agr. Exptl. Sta., Wooster.)

American Soc. of Human Genetics. (D. C. Rife, Ohio State Univ., Columbus.)

American Soc. of Limnology and Oceanography. (B. H. Ketchum, Woods Hole Oceanographic Inst., Woods Hole, Mass.)

American Soc. of Naturalists. (W. P. Spencer, Dept. of Genetics, Univ. of Texas, Austin 12.)

American Soc. of Plant Physiologists. (J. F. Stanfield, Dept. of Botany, Miami Univ., Oxford, Ohio.)

American Soc. of Plant Taxonomists. (R. C. Rollins, Gray Herbarium, Harvard Univ., Cambridge 38, Mass.)

American Soc. of Zoologists. (R. C. Kempton, Dept. of Zoology, Vassar College, Poughkeepsie, N.Y.)

Beta Beta Beta. (B. R. Weimer, Bethany College, Bethany, W.Va.)

Biometric Soc. (C. I. Bliss, Box 1106, New Haven 4, Conn.)

Botanical Soc. of America. (H. C. Bold, Dept. of Biology, Vanderbilt Univ., Nashville, Tenn.)

Ecological Soc. of Ameria. (J. F. Reed, Dept. of Botany, Univ. of Wyoming, Laramie.)

Genetics Soc. of America. (C. P. Oliver, Dept. of Zoology, Univ. of Texas, Austin.)

Mycological Soc. of America. (E. S. Beneke, Botany and Plant Pathology Dept., Michigan State Univ., East Lansing.)

National Assoc. of Biology Teachers. (P. V. Webster, Bryan City Schools, Bryan, Ohio.)

Nature Conservancy. (G. B. Fell, 4200 22 St., NE, Washington 18.)

Phycological Soc. (P. C. Silva, Dept. of Botany, Univ. of Illinois, Urbana.)

Potato Assoc. of America. (R. W. Hougas, Dept. of Genetics, Univ. of Wisconsin, Madison 6.)

Soc. for Industrial Microbiology. (C. L. Porter, Dept. of Biological Sciences, Purdue Univ., West Lafayette, Ind.)

Soc. of Protozoologists. (N. D. Levine, College of Veterinary Medicine, Univ. of Illinois, Urbana.)

Soc. for the Study of Evolution. (H. Lewis, Dept. of Botany, Univ. of California, Los Angeles 24.)

Soc. of Systematic Zoologists, (R. E. Blackwelder, 3728 Second St. South, Arlington 4, Va.)

5–9. Econometric Soc., Ann Arbor, Mich. (R. Ruggles, Box 1264, Yale Station, New Haven, Conn.)

5–10. World Cong. of Anaesthesiologists, Scheveningen, Netherlands. (W. A. Fentener van Vlissingen, WCA, Bilthoven, Netherlands.)

6–11. American Physiological Soc., Boston, Mass. (M. O. Lee, APS, 9650 Wisconsin Ave., Washington 14.)

6–16. Chicago Inst. for Hospital Administrators, 23rd, Chicago, Ill. (American College of Hospital Administrators, 620 N. Michigan Ave., Chicago 11.)

7–9. American Political Science Assoc., Boulder, Colo. (E. M. Kirkpatrick, 1785 Massachusetts Ave., NW, Washington 6.)

7–9. American Soc. of Photogrammetry, Los Angeles, Calif. (C. E. Palmer, 1000 11 St., NW, Washington 1.)

7–9. International Symposium on Arteriosclerosis, Minneapolis, Minn. (American Heart Assoc., 44 E. 23 St., New York 10.)

9–10. Soc. of General Physiologists, Woods Hole, Mass. (J. B. Buck, NIH, Bethesda 14, Md.)

9–10. Symposium on Electroluminescence and Photoconduction in Inorganic Phosphors, Brooklyn, N.Y. (J. J. Dropkin, Polytechnic Inst. of Brooklyn, Brooklyn 1.)

9–12. Sigma Delta Epsilon, Minneapolis, Minn. (Mary Gojdics, Barat College, Lake Forest, Ill.)

(*Continued on page 256*)

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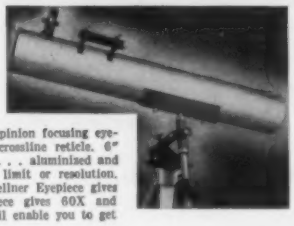

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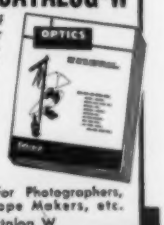

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(*Continued from page 254*)

10. International Conf. of Medical and Reference Librarians, Brussels, Belgium. (Miss C. de Looze, Oeuvre Nationale Belge de Defense contre la Tuberculose, 56, rue de la Concorde, Bruxelles.)

10–11. Soc. for Social Responsibility in Science, annual, Swarthmore, Pa. (J. Engelberg, 4715 Baltimore Ave., Philadelphia 43, Pa.)

10–15. International Cong. on Cosmic Radiation, Mexico, D.F., Mexico. (H. A. Barton, IUPAP, 57 E. 55 St., New York 22.)

11–16. American Chemical Soc., Minneapolis, Minn. (A. H. Emery, 1155 16 St., NW, Washington 6.)

11–16. Laurentian Hormone Conf. AAAS, annual, Estes Park, Colo. (Committee on Arrangements, 222 Maple Ave., Shrewsbury, Mass.)

11–18. International Cong. of Criminology, London, Eng. (State Univ. of New York, College of Medicine at New York City, 469 Clarkson Ave., Brooklyn 3.)

11–18. International Cong. of Librarianship and Documentation, Brussels, Belgium. (M. A. Baby, 8, rue de Haguenau, Strasbourg, France.)

12–13. Meteoritical Soc., 18th, Albuquerque, N.M. (J. A. Russell, Dept. of Astronomy, Univ. of Southern California, Los Angeles 7.)

12–13. Pi Gamma Mu National Convention, Allerton Park, Ill. (E. B. Urquhart, 1719 Ames St., Winfield, Kan.)

12–14. Soil Conservation Soc. of America, Green Lake, Wis. (H. W. Pritchard, Paramount Bldg., Des Moines, Ia.)

12–15. International College of Surgeons, 20th annual, Philadelphia, Pa. (K. A. Meyer, 1516 Lake Shore Dr., Chicago 10, Ill.)

12–16. Illuminating Engineering Soc., annual, Cleveland, Ohio. (A. D. Hinckley, 1860 Broadway, New York 23.)

12–16. Instrument Soc. of America, 10th annual, Los Angeles, Calif. (Fred Tabery, 3443 S. Hill St., Los Angeles.)

13–15. American Meteorological Soc., Asbury Park, N.J. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

14–16. American Assoc. of Clinical Chemists, 7th annual, Minneapolis, Minn. (M. M. Friedman, Lebanon Hospital, New York 57.)

14–16. Assoc. for Computing Machinery, annual, Philadelphia, Pa. (J. P. Nash, Digital Computer Lab., Univ. of Illinois, Urbana.)

15–16. Corrosion Symposium, Montreal, Canada. (Chemical Inst. of Canada, 18 Rideau St., Ottawa 2.)

15–17. International Soc. for the Study of Biological Rhythm, 5th conf., Stockholm, Sweden. (T. Petrén, Karolinska Institutet, Stockholm 60.)

16–17. American Psychiatric Assoc. Midwest Regional Research Conf., Galesburg, Ill. (L. H. Rudy, Galesburg State Research Hospital, Galesburg.)

16–17. Calorimetry Conf., 10th annual, Minneapolis, Minn. (E. F. Westrum, Jr., Dept. of Chemistry, Univ. of Michigan, Ann Arbor.)

17–21. American College of Hospital Administrators, 21st annual, Atlantic City, N.J. (D. Conley, ACHA, 620 N. Michigan Ave., Chicago 11, Ill.)

19–23. Fédération Internationale Pharmaceutique, 16th general assembly, London, Eng. (D. F. Lewis, Secy., Organizing Committee, FIP, 17 Bloomsbury Sq., London W.C.1.)

20–23. American Roentgen Ray Soc., Chicago, Ill. (B. R. Young, Germantown Hospital, Philadelphia 44, Pa.)

20–26. World Medical Assoc., 2nd congress, Vienna, Austria. (L. H. Bauer, 345 E. 46 St., New York 17.)

22–23. Symposium on the Less Common Metals, London, Eng. (W. J. Felton, Institution of Mining and Metallurgy, Salisbury House, London, E.C.2.)

23–24. Symposium on the Biologic Effects of Microwaves, Rochester, Minn. (J. F. Herrick, Section of Biophysics, Mayo Clinic, Rochester.)

25–28. American Inst. of Chemical Engineers, Lake Placid, N.Y. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York.)

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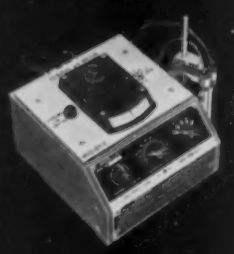

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4. Programs of the 17 AAAS sections (symposia and contributed papers).
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7. Details of the Municipal Auditorium—center of the Meeting—and hotels and campuses.
8. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
9. Exhibitors in the 1955 Annual Exposition of Science and Industry and descriptions of their exhibits.

Directory content

1. AAAS officers, staff, committees for 1955.
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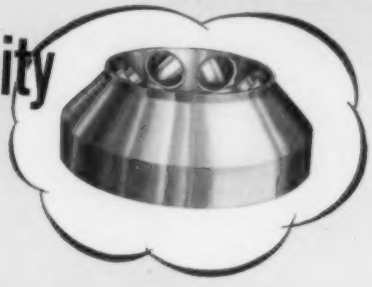

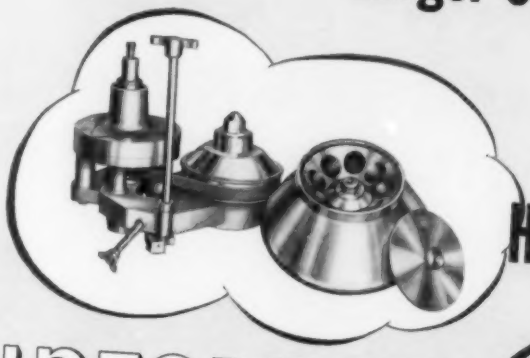

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